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### Title:

IEC 61993 - Maritime navigation and radiocommunication equipment and systems - Part 2: Universal shipborne automatic identification system - Performance requirements, methods of testing and required test results

(Titre) :

### Introductory note

IMO Introduced the Universal Automatic Identity system (UAIS) at MSC 69 and the IMO performance standard is MSC.74(69) - Annex 3. The corresponding ITU recommendation is ITU-R RM.1371

Work has been progressing well in WG8A of TC80 in drafting the IEC Standard, however a number of clarifications to RM.1371 have become necessary.

As this cannot be done until the next meeting of ITU-R WP8B which is in Geneva 2000-10-17, it was decided to get initial approval of the working draft as a CD with the proposed clarifications to RM.1371 attached as an Annex.

Comments to this CD are urgently needed at the next meeting of the WG which is in Canada 19th - 22nd September 2000

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MARITIME NAVIGATION AND RADIOCOMMUNICATION  
EQUIPMENT AND SYSTEMS –****Universal Shipborne automatic identification system (AIS) installation using  
VHF TDMA techniques**

## FOREWORD

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International Standard IEC 61993-2 has been prepared by workgroup 8A of IEC technical committee 80:

The text of this standard is based on the following documents:

FDIS	Report on voting
XX/XX/FDIS	XX/XX/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

The committee has decided that the contents of this publication will remain unchanged until IMO or ITU have updated the source documents for this International Standard. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

## INTRODUCTION

IEC 61993-2 was set up as a work item by IEC at the request of the marine electronics industry, following the adoption by the International Maritime Organisation (IMO) of Resolution MSC.74(69)

Annex 3, Universal Shipborne Automatic Identification System, giving the performance requirements for such a system. Technical requirements are provided in ITU-R M.1371 "Technical characteristics for a universal shipborne Automatic Identification System (AIS) using TDMA (Self Organising Time Division Multiple Access) in the VHF maritime mobile band". Carriage requirements for SOLAS ships are now being approved by IMO for adoption before the end of the year and entry into force starting by July 1<sup>st</sup> 2002.

The AIS is based on a technology that is still in an evolutionary stage, in the marine industry at least. This has been a considerable burden on the working group. No other IEC publications on similar technology have been found. As a consequence, it was felt that before finishing the work, the Working Group should be able to consult with experts outside the group. Permission was obtained from TC80 to circulate a first draft to obtain comments at an intermediate stage of the work, especially on sources of standard test methods, particularly for digital radio measurements.

In the course of the work, it was found that ITU R Recommendation M.1371 needed several clarifications. The present Committee draft incorporates the amendments prepared by IALA Committee on AIS for presentation to ITU R Study group 8B.

The present Committee draft also takes into account the provisional results of the work of IMO on operational requirements for AIS.

The Committee Draft for Voting is expected to be ready by the end of 2000, at which time the decisions of both IMO and ITU will be known. The CDV will thus incorporate those final texts.

Square brackets are included in every place where full consideration has not yet been given to the text. Most cross-references have not been verified. This will be done after CD comments have been received.

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# INTERNATIONAL ELECTROTECHNICAL COMMISSION

## MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS

### IEC 61993 Part 2: Universal Shipborne Automatic Identification System (AIS) Operational and performance requirements, methods of testing and required test results

#### 1 Scope

This International Standard specifies the minimum operational and performance requirements, methods of testing and required test results conforming to performance standards adopted by the IMO in resolution MSC.74(69) Annex 3 Universal Shipborne Automatic Identification System. This standard incorporates the technical characteristics included in Recommendation ITU-R M.1371 and takes into account the ITU Radio Regulations where applicable. In addition it takes account of IMO resolution A.694(17) to which IEC 60945 is associated. When a requirement of this standard is different from IEC 60945, the requirement in this standard shall take precedence.

This standard considers the shipborne equipment taking account of both the "protected" and "exposed" categories in accordance with IEC 60945. Carry-aboard equipment, may be considered as "protected" or "exposed" as applicable.\*\*\*

This International Standard specifies the minimum requirements both for the means to input and display data and for the interfaces to other equipment suitable to be used as means of input and display data.

Note: All text of this standard, that is identical to that in IMO resolution MSC.74(69) Annex 3 and IMO resolution A.694(17) or to that in ITU-R M.1371 is printed in *italics* and the resolution (abbreviated to - A3) or the recommendation (abbreviated to - M.1371) and paragraph numbers are indicated in parentheses i.e. (A3/3.3) or (M.1371/3.3) respectively.

Statements on base stations and repeaters are provided in order to specify the behaviour of a mobile station in an environment which includes (a) base station(s) and / or (a) repeater(s).

#### 2 Normative References

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60936-1 Ed. 1.0 Maritime navigation and radiocommunication equipment and systems - Radar - Part 1: Shipborne radar - Performance requirements - Methods of testing and required test results

IEC 60945 Ed. 3.0 Maritime navigation and radiocommunication equipment and systems - General requirements - Methods of testing and required test results.

IEC 61097-7 Ed. 1.0 Global maritime distress and safety system (GMDSS) - Part 7: Shipborne VHF radiotelephone transmitter and receiver - Operational and performance requirements, methods of testing and required test results.

IEC 61108-1 Ed. 1.0 Global navigation satellite systems (GNSS) - Part 1: Global positioning system (GPS) - Receiver equipment - Performance standards, methods of testing and required test results.

IEC 61108-2 Ed. 1.0 Maritime navigation and radiocommunication equipment and systems - Global navigation satellite systems (GNSS) - Part 2: Global navigation satellite system (GLONASS) - Receiver equipment - Performance standards, methods of testing and required test results.

IEC 61108-4: .... DGNSS.\*\*\*.(Not yet in the IEC catalogue.)

IEC 61162-1 Ed. 1.0 Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 1: Single talker and multiple listeners.

IEC 61162-2 Ed. 1.0 Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 2: Single talker and multiple listeners, high-speed transmission.

IEC 61162-3: Digital interfaces - Part 3: Multiple Talker and multiple listeners. High speed network bus. Future publication.

IEC 61174 Ed. 1.0 Maritime navigation and radiocommunication equipment and systems - Electronic chart display and information system (ECDIS) - Operational and performance requirements, methods of testing and required test results.

IEC 61993-1 Ed. 1.0 Maritime navigation and radiocommunication equipment and systems - Part 1: Shipborne automatic transponder system installation using VHF digital selective calling (DSC) techniques - Operational and performance requirements, methods of testing and required test results.

ISO/IEC 3309: 1993 Information technology -- Telecommunications and information exchange between systems -- High-level data link control (HDLC) procedures -- Frame structure

ISO 9001:1994 Quality systems -- Model for quality assurance in design, development, production, installation and servicing

ISO 9001/DIS Quality management systems -- Requirements (*Ed. 3*)

ISO 9002: 1994 Quality systems -- Model for quality assurance in production, installation and servicing

ISO 9003: 1994 Quality systems -- Model for quality assurance in final inspection and test

ISO DIS 9004 Quality management systems -- Guidelines for performance improvements

ISO 9004-1 Quality management and quality system elements -- Part 1: Guidelines

ISO 9004-2 Quality management and quality system elements -- Part 2: Guidelines for services

ISO 9004-3: 1993 Quality management and quality system elements -- Part 3: Guidelines for processed materials

ISO 9004-4 Quality management and quality system elements -- Part 4: Guidelines for quality improvement

IMO MSC.43(64) Guidelines and Criteria for Ship Reporting Systems

IMO MSC.74(69) Annex 3 Recommendation on performance standards for AIS.

IMO A.694(17) (1991) General requirements

IMO Resolution A.851(20): General principles for ship reporting.

ITU Radio Regulations

ITU-R M.823-2 (10/97) Technical characteristics of differential transmissions for Global Navigation Satellite Systems from maritime radio beacons in the frequency band 283.5-315 kHz in Region 1 and 285-325 kHz in Regions 2 and 3.

ITU-R M.825-3 (10/98) Characteristics of a transponder system using digital selective calling techniques for use with vessel traffic services and ship-to-ship identification.

ITU-R M.1084-3 (10/98) Interim solutions for improved efficiency in the use of the band 156-174 MHz by stations in the maritime mobile service.

**Note:** ITU-R M.1371 references ITU-R M.1084-2, Annex 3. A Draft Revision of Recommendation ITU-R M.1084-2, consequentially leading to ITU-R M.1084-3, has been approved in parallel to the approval of ITU-R M.1371. While the content of the former Annex 3 remains unchanged, it had been renumbered to Annex 4 of ITU-R M.1371. Throughout this international standard the latest version, i.e. ITU-R M.1084-3, and therefore Annex 4 will be referenced.

ITU-R M.1371 (10/98) Technical characteristics for a universal shipborne automatic identification system using time division multiple access in the VHF maritime mobile band.

### 3 Definitions and abbreviations

#### 3.1 Definitions

A glossary of AIS related terms is given in Annex A.

For the purposes of this standard the following definitions and abbreviations apply. 3.1.1.

##### 3.1.1

##### **Consistent Common Reference System**

Sensor input data, providing identical and obligatory reference pertaining but not limited to: position, course, heading, bearing, speed, velocity, and horizontal datum to different sub-systems within an integrated navigation system.

##### 3.1.2

##### **Built In Integrity Test**

Tests that run continuously or at appropriate intervals simultaneously with the standard functions of the equipment. This BIIT is to satisfy the IMO required BITE (Built in Test Equipment). AIS Universal shipborne Automatic Identification System

##### 3.1.3

##### **"Carry on board" equipment**

TBD

#### 3.2 Abbreviations

AIS	Universal shipborne Automatic Identification System
BT	Product bandwidth time product***
CPU	Central Processing Unit
ECDIS	Electronic chart display and information system
EPFS	Electronic position fixing system
ETA	Estimated Time of Arrival
EUT	Equipment under test
HSC	High speed craft
IHO	International Hydrographic Office
IMO	International Maritime Organisation
LR	Long Range
MAC	Medium access control
NUC	Not under command
PI	Presentation Interface
Rx	Receive

Tx	Transmit
UTC	Universal Time Coordinated
VDL	VHF Data Link
VDM	VHF Data Message
VSWR	Voltage Standing Wave Ratio

## 4 General requirements

Requirements contained in this clause 4 are requirements not taken up in other clauses and which cannot be verified by repeatable methods of measurement. These requirements include the applicable general and operational requirements of IEC 60945, as detailed in clauses 6 (Operational checks), 13 (Maintenance), 14 (Equipment manuals) and 15 (Marking and Identification).

The manufacturer shall declare compliance with these requirements and shall provide relevant documentation. The declarations, documentation and where necessary, the EUT shall be checked/verified by inspection.

The manufacturer shall also declare the composition of the EUT and the category for durability and resistance to environmental conditions for each unit of the EUT as specified in IEC 60945.

### 4.1 General

#### 4.1.1 General requirements

4.1.1.1 (A3/1.1) *This standard specifies the requirements for the universal AIS.*

The performance of the universal automatic identification system shall not be inferior to the performance requirements adopted by the IMO in MSC.74(69) Annex 3 AIS.

4.1.1.2(A3/1.2) *The AIS shall improve the safety of navigation by assisting in the efficient navigation of ships, protection of the environment, and operation of Vessel Traffic Services (VTS), by satisfying the following functional requirements:*

4.1.1.2.1 *in a ship-to-ship mode for collision avoidance;*

4.1.1.2.2 *as a means for littoral States to obtain information about a ship and its cargo;*  
*and*

4.1.1.2.3 *as a VTS tool, i.e. ship-to-shore (traffic management).*

#### 4.1.2 Capabilities of the AIS

(A3/1.3) *The AIS shall be capable of providing to ships and to competent authorities, information from the ship, automatically and with the required accuracy and frequency, to facilitate accurate tracking. Transmission of the data shall be with the minimum involvement of ship's personnel and with a high level of availability.*

#### 4.1.3 Additional requirements

(A3/1.4) *The installation, in addition to meeting the requirements of the Radio Regulations, applicable ITU-R Recommendations and the general requirements as set out in resolution A.694 (17), shall comply with the following performance standards, as contained in the following clauses.*

#### 4.1.4 Quality assurance

The AIS shall be designed, produced and documented by companies complying with ISO 9000 series standards as applicable.

## 4.2 (A3/2) Modes of Operation

### 4.2.1 General

(A3/2.1) The system shall be capable of operating in a number of modes:

4.2.1.1 an "autonomous and continuous" mode for operation in all areas. This mode shall be capable of being switched to/from one of the following alternate modes by a competent authority;

Autonomous and continuous operation shall be as described in 3.3.5 of Annex 2 of Recommendation ITU-R M.1371;

4.2.1.2 an "assigned" mode for operation in an area subject to a competent authority responsible for traffic monitoring such that the data transmission interval and/or time slots may be set remotely by that authority;

Assigned operation shall be as described in 3.3.6 of Annex 2 of Recommendation ITU-R M.1371 and in 8.1.3 of Annex 1 of Recommendation ITU-R M.825-3 for DSC compatibility; *and*

4.2.1.3 a "polling" or controlled mode where the data transfer occurs in response to interrogation from a ship or competent authority.

Polling operation shall be as described in 3.3.6 of Annex 2 of ITU-R M.1371 and in Annex 1 of Recommendation ITU-R M.825-3 - for DSC compatibility.

### 4.2.2 Criteria for reporting

(A3/6.3) *To protect the unauthorised dissemination of data, the IMO guidelines (Guidelines and Criteria for Ship Reporting Systems)<sup>1</sup> shall be followed.*

## 4.3 Manuals

In addition to the requirements of IEC 60945 clause 14, the manuals shall include:

- The type of external connector required for connection of the display as referred to in 5.12.3.
- The needed information for correct siting of the antennas.
- The requirements for external illumination, as appropriate.
- The details of the needed external audible and visual alarm device (See 5.10).

## 4.4 Marking and identification

In addition to the requirements of IEC 60945, clause 15, the markings shall include:

- 1) details of the power supply from which the equipment is intended to be operated; and if applicable,
- 2) date by which batteries need to be replaced.

## 5 Environmental, power supply, special purpose and safety requirements

The testing for showing compliance with the environmental, power supply, special purpose and safety requirements of IMO A.694(17) as detailed in IEC 60945 and for which a repeatable method of measurement has been defined, are detailed in 11, 12 and 13 of this standard.

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<sup>1</sup> Resolution MSC.43(64)

## 6 Performance requirements

### 6.1 (A3/3) Composition

6.1.1(A3/3.1) *The AIS shall comprise:*

6.1.1.1 *a communication processor, capable of operating over a range of maritime frequencies, with an appropriate channel selecting and switching method, in support of both short (VHF) and long (beyond VHF) range applications. For long range applications the AIS shall provide a two-way interface which complies with IEC 61162;*

6.1.1.2 *at least one transmitter, two TDMA receivers and one dedicated DSC receiver tuned to channel 70;*

6.1.1.3 *a means of processing data from an electronic position-fixing system which provides a resolution of one ten thousandth of a minute of arc and uses the WGS-84 datum. An interface (IEC 61162 ) shall be provided to input the position used for navigation.*

Position information, if available from other EPFS, shall be used only as a back-up and the user shall be informed of this.

The internal GNSS receiver, when used as a backup, shall meet the accuracy requirements of IEC 61108. On changeover a new message 5 shall be transmitted immediately giving the reference point for the reported position.

6.1.1.4 *a means to automatically input data from other sensors meeting the provisions as specified in paragraph 5.4.1.2; A means, external to the AIS, to comply with this requirement shall be tested to the applicable requirements of IEC 60945.*

6.1.1.6 *a means to input and retrieve data manually.* The possibility of manual input and retrieval shall be demonstrated based on the manufacturer's documentation

6.1.1.7 *a means of error checking the transmitted and received data; and*

6.1.1.8 *built in test equipment (BITE)*

6.1.2(A3/3.2) *The AIS shall be capable of:*

6.1.2.1 *providing information automatically and continuously to a competent authority and other ships, without involvement of ship's personnel;*

6.1.2.2 *receiving and processing information from other sources, including that from a competent authority and from other ships;*

6.1.2.3 *responding to high priority and safety related calls with a minimum of delay (refer to 6.3.3.4.2.2, and to 6.4.2.2.1); and*

6.1.2.4 *providing positional and manoeuvring information at a data rate adequate to facilitate accurate tracking by a competent authority and other ships. ( See 5.4.2 ).*

### 6.2 (A3/4) User interface

*To enable a user to access, select and display the information on a separate system, the AIS shall be provided with an interface conforming to an appropriate international marine interface standard. ( See IEC 61162 )*

### 6.3 (A3/5) Identification

*For the purpose of ship and message identification, the appropriate Maritime Mobile Service Identity (MMSI) number shall be used.*

### 6.4 (A3/6) Information

#### 6.4.1 (A3/6.1) Information provided by the AIS

*The information provided by the AIS shall include:*

##### 6.4.1.1 Static:

*IMO number (where available)*

*Call sign & name*

*Length and beam*

*Type of ship*

*Location of the in use position-fixing antenna on the ship (aft of bow and port or starboard of centreline)*

##### 6.4.1.2 Dynamic:

*Ship's position with accuracy indication and integrity status*

*Time in UTC<sup>2</sup>*

*Course over ground (COG).*

*Speed over ground (SOG).*

*Heading.*

*Navigational status (e.g. not under command (NUC), at anchor, etc. - manual input)*

*Rate of turn (where available)*

##### 6.4.1.3 Voyage related:

*Ship's draught*

*Hazardous cargo (type; as required by a competent authority).*

*Destination and estimated time of arrival (ETA) (at masters discretion)*

*optional - Route plan (waypoints; textual description, at master's discretion and upon interrogation by a competent authority, only).*

##### 6.4.1.4 Short safety-related messages

#### 6.4.2 (A3/6.2) Information update rates for autonomous mode

*The different information types are valid for a different time period and thus need a different update rate.*

*Static information: Every 6 min. and on request.*

*Dynamic Information: Dependent on speed and course alteration according to Table 1.*

*Voyage related information: Every 6min, when data has been amended, and on request*

*Safety-related message: As required.*

**Table 1**

<i>Type of Ship</i>	<i>Reporting interval</i>
<i>Ship at anchor</i>	<i>3 min</i>

<sup>2</sup> Date to be established by receiving equipment

<i>ship 0 – 14 knots</i>	<i>12 sec</i>
<i>ship 0 – 14 knots and changing course</i>	<i>4 sec</i>
<i>ship 14 – 23 knots</i>	<i>6 sec</i>
<i>ship 14 - 23 knots and changing course</i>	<i>2 sec</i>
<i>ship &gt; 23 knots</i>	<i>3 sec</i>
<i>ship &gt; 23 knots and changing course</i>	<i>2 sec</i>

#### **6.4.3 (A3/6.2) Ship Reporting Capacity**

*The system shall be able to handle a minimum of 2000 reports per minute, to adequately provide for all operational scenarios envisioned.*

The system is capable of handling 4500 reports per minute on two channels (see 7.4.2).

#### **6.5 (A3/6.3) Security**

*A security mechanism shall be provided to detect disabling of the AIS and to prevent unauthorised alteration of input or transmitted data. To protect the unauthorised dissemination of data, the IMO guidelines (Guidelines for Ship Reporting Systems) shall be followed.*

Means shall be provided to automatically record all periods when the AIS installation is non-functioning. It shall not be possible for the user to alter any information recorded by this device.

The last 10 times when the equipment was non-functioning for more than 15 min shall be recorded, in UTC time and duration, in a non-volatile memory. Means shall be provided to recover this data.

#### **6.6 (A3/7) Permissible initialisation period**

*The installation shall be operational within 2 min of switching on.*

Note: Sensors used with the AIS shall meet the requirements of their individual product standards ( for example - IEC 61108-1 for GPS which permits 30 min to operation when there is no valid almanac data available, or IEC 61108-2 for GLONASS).

#### **6.7 (A3/8) Power supply**

*The AIS and associated sensors shall be powered from the ship's main source of electrical energy. In addition, it shall be possible to operate the AIS and associated sensors from an alternative source of electrical energy.*

#### **6.8 (A3/9) Technical characteristics**

*The technical characteristics of the AIS such as variable transmitter output power, operating frequencies (dedicated internationally and selected regionally), modulation, and antenna system shall comply with the appropriate ITU-R Recommendations.*

#### **6.9 Interfacing**

All interfacing shall be made via the system interface as described in 7.9 (called presentation interface). Where a suitable IEC 61162 interface standard is available, it shall be used.

If no suitable IEC 61162 interface standard is available, an alternative appropriate interface may be used.

#### **6.10 Alarms and indications, fall-back arrangements**

##### **6.10.1 Built in integrity test (BIIT)**

The AIS shall be equipped with built in integrity tests (BIITs). They shall run continuously or in appropriate intervals simultaneously with the standard functions of the equipment.

In case any failure or malfunction is detected, a corresponding output data stream shall be generated as far as possible. The data shall be available on both an IEC 61162-2 output port. This data stream is evaluated by systems connected to the output and corresponding indications or alarms are generated there. The AIS shall be capable of accepting acknowledgements for alarms and indications from external equipment and set the alarm status accordingly.

During periods when no malfunction or alarm condition is present after every 30 s (latest) an empty alarm message shall be transmitted.

For further detail see normative annex B.

A NC/NO (normally closed / normally open) earth free relay contact shall be provided as an independent and simple method for the generation of an alarm by means of an external alarm device. This relay shall operate in case of any loss of data, malfunction or failure.

### 6.10.2 Monitoring of data availability

In case one or more of the following data is missing, invalid or of detectable unreliability an indication shall be given and the system shall react as given in the Table 2:

**Table 2**

Effected data	Reaction of the system
Speed over ground lost(invalid)	Continue operation without using the effected data
Course over ground lost/invalid	Continue operation without using the effected data
Rate of turn lost/invalid	Continue operation without using the effected data
Heading lost(invalid)	Continue operation without using the effected data

### 6.10.3 Monitoring of functions and integrity

In case a failure is detected in one or more of the following functions or data an alarm shall be triggered and the system shall react as given in Table 3 and Table 4.

**Table 3**

Continuous integrity tests	Reaction of the system
Position lost/invalid	Complete scheduled transmissions, then stop transmission
Power supplies defective	Stop transmission
TX synthesiser not locked	Stop transmission
UTC clock lost	Continue operation use indirect synchronisation
TX power too low	Continue operation
TX too long on the air	Stop repeated transmission
TX failure (no output power)	-----
Antenna VSWR exceeds limit	Continue operation with reduced power
RX malfunction	Stop transmission on relevant channel
CPU/program failure	Stop transmission

**Table 4**

Power On integrity tests	Reaction of the system
GNSS module status invalid	Stop or do not start transmission if there are no external data available which allow operation with reduced data and with conversion to indirect synchronisation

Program memory (checksum)	Stop or do not start transmission
Stored variable data error (checksum)	Stop or do not start transmission, request new input if possible

## **6.11 Ergonomics**

[see IEC 60945]

## **6.12 Display, input and output**

The AIS shall provide means to display ship and shore based AIS data and manually input data as follows:

### **6.12.1 Required display and manual input functions**

Display and manual input device to provide the following functions:

- Display of at least three (3) lines of data. Each line to display at least bearing, range, and name of ship. Horizontal scrolling of bearing and range is not allowed. The title of display data shall be visible.
- Manually input voyages and safety related messages, control of AIS, and data selection.

### **6.12.2 I/O ports**

An I/O port shall be provided to display and input ship data on other radio navigation equipment not covered by this specification, e. g. Radar, ECDIS, or additional display and keyboard.

An additional I/O port shall be provided to display ship data on AIS “carry aboard” equipment.

7 Technical requirements

7.1 General

This clause covers layers 1 to 4 (Physical Layer, Link Layer, Network Layer, Transport Layer) of the Open System Interconnection (OSI) model.

Figure 1 illustrates the layer model of an AIS station (Physical Layer to Transport Layer) and the layers of the applications (Session Layer to Application Layer):

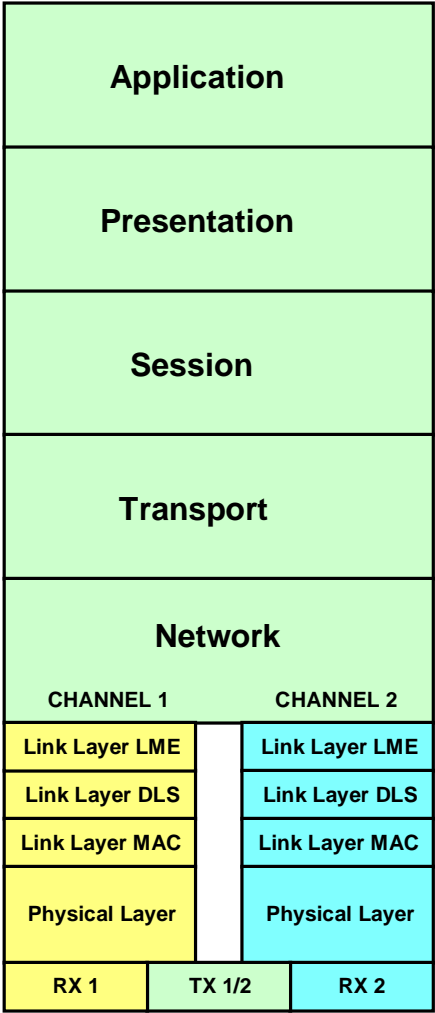


Figure 1

## 7.2 Physical layer

### 7.2.1 Parameters

#### 7.2.1.1 (M.1371/A2-2.1.1) General

The Physical layer is responsible for the transfer of a bit-stream from an originator out, on to the data link. The performance requirements for the physical layer are summarised in Table 5 to Table 7.

**Table 5**

Symbol	Parameter Name	Low setting	High setting
PH.RFR	Regional Frequencies (range of frequencies within ITU-R.M1084-3)	156.025 MHz	162.025 MHz
PH.CHS	Channel Spacing (encoded according to ITU-R.M1084-3)	12.5 kHz	25 kHz
PH.AIS1	AIS 1 (default channel 1) (Ch 87B), (2087) <sup>3</sup> (refer to 7.2.4.3)	161.975 MHz	161.975 MHz
PH.AIS2	AIS 2 (default channel 2) (Ch 88B), (2088) <sup>3</sup> (refer to 7.2.4.3)	162.025 MHz	162.025 MHz
PH.CHB	Channel Bandwidth	12.5 kHz	25 kHz
PH.BR	Bit Rate	9600 bps	9600 bps
PH.TS	Training Sequence	24 bits	32 bits
PH.TST	Transmitter Settling Time Transmit power within 20% of final value, Frequency stable to within $\pm 1.0$ kHz of final value	1.0 ms	1.0 ms
PH.TXP	Transmit Output Power	2 Watt	12,5 Watt

For Transmit Output Power see also 7.2.13.

The low setting and the high setting for each parameter is independent of the other parameters.

#### 7.2.1.2 (M.1371/A2-2.1.2) Constants

**Table 6**

Symbol	Parameter Name	Value
PH.DE	Data Encoding	NRZI
PH.FEC	Forward Error Correction	Not used
PH.IL	Interleaving	Not used
PH.BS	Bit Scrambling	Not used
PH.MOD	Modulation	Bandwidth adapted GMSK/FM

NRZI: non-return to zero inverted

GMSK/FM: see 7.2.4

<sup>3</sup> See Recommendation ITU-R M.1084-3

### 7.2.1.3 (M.1371/A2-2.1.3) Bandwidth dependent parameters

Table 7 below defines settings dependent on parameter PH.CHB.

**Table 7**

Symbol	Parameter Name	PH.CHB (12.5 kHz)	PH.CHB (25.0 kHz)
PH.TXBT	Transmit BT-product	0.3	0.4
PH.RXBT	Receive BT-product	0.3/0.5	0.5
PH.MI	Modulation Index	0.25	0.50

Note: Information about resulting coverage range is given in Annex E informative).

### 7.2.1.4 (M.1371/A2-2.1.4) Transmission media

Data transmissions shall be made in the VHF maritime mobile band. Data transmissions shall default to AIS 1 and AIS 2 unless otherwise specified by a competent authority, as described in 7.7.1 and 8. See Annex H concerning long range applications.

### 7.2.1.5 (M.1371/A3-1) Dual Channel Operation

The transponder shall be capable of operating on two parallel channels in accordance with section 7.7.1. Two separate TDMA receivers shall be used to simultaneously receive information on two independent frequency channels. One TDMA transmitter shall be used to alternate TDMA transmissions on two independent frequency channels.

### 7.2.2 (M.1371/A2-2.2) Bandwidth

The AIS shall be capable of operating with a channel bandwidth of 25 kHz or 12.5 kHz according to Recommendation ITU-R M.1084-3 and Appendix S18 of the Radio Regulations. 25 kHz bandwidth shall be used on the high seas whereas 25 kHz or 12.5 kHz channel bandwidth shall be used as defined by the appropriate authority in territorial waters, as described in 6.4.1 and 7.

### 7.2.3 (M.1371/A2-2.3) Transceiver characteristics

The transceiver shall perform in accordance with the standards set forth herein.

### 7.2.4 (M.1371/A2-2.4) Modulation scheme

The modulation scheme shall be bandwidth adapted frequency modulated Gaussian Minimum Shift Keying - GMSK/FM.

#### 7.2.4.1 (M.1371/A2-2.4.1) GMSK

(M.1371/A2-2.4.1.1) The Non-Return to Zero Inverted (NRZI) encoded data shall be GMSK coded before frequency modulating the transmitter.

(M.1371/A2-2.4.1.2) The GMSK modulator Bandwidth Time product (BT-product) used for transmission of data shall be 0.4 maximum when operating on a 25 kHz channel, and 0.3 when operating on a 12.5 kHz channel.

(M.1371/A2-2.4.1.3) The GMSK demodulator used for receiving of data shall be designed for a BT-product of maximum 0.5 when operating on a 25 kHz channel and 0.3 or 0.5 when operating on a 12.5 kHz channel.

#### 7.2.4.2 (M.1371/A2-2.4.2) Frequency modulation

The GMSK coded data shall frequency modulate the VHF transmitter. The modulation index shall be 0.5 when operating on a 25 kHz channel and 0.25 when operating on a 12.5 kHz channel.

#### **7.2.4.3 Frequency stability**

*The frequency of the VHF radio transmitter/receiver shall be better than  $\pm 3$  ppm.*

#### **7.2.5 (M.1371/A2-2.5) Data transmission bit rate**

*The transmission bit rate shall be 9600 bits/s  $\pm 50$  ppm.*

#### **7.2.6 (M.1371/A2-2.6) Training sequence**

*Data transmission shall begin with a 24-bit demodulator training sequence (preamble) consisting of one segment synchronisation. This segment shall consist of alternating zeros and ones (0101....). This sequence may begin with a 1 or a 0 since NRZI encoding shall be used. Optionally, a 32 bit training sequence may be used when the environment so requires. In this case, a reduction in distance delay may be used to compensate. The default operation of the transponder shall use a 24-bit training sequence.*

*Changes to the training sequence shall be by assignment only on receipt of "Channel Management" Message 22.*

#### **7.2.7 (M.1371/A2-2.7) Data encoding**

*The NRZI waveform shall be used for data encoding. The waveform is specified as giving a change in the level when a zero (0) is encountered in the bit stream.*

#### **7.2.8 (M.1371/A2-2.8) Forward error correction**

*Forward error correction shall not be used.*

#### **7.2.9 (M.1371/A2-2.9) Interleaving**

*Interleaving shall be not used.*

#### **7.2.10 (M.1371/A2-2.10) Bit scrambling**

*Bit scrambling shall not be used.*

#### **7.2.11 (M.1371/A2-2.11) Data link sensing**

*Data link occupancy and data detection shall be entirely controlled by the Link layer.*

#### **7.2.12 (M.1371/A2-2.12) Transmitter settling time**

*The RF settling characteristics shall ensure that the transceiver requirements in 7.2.3 are met.*

##### **7.2.12.1 (M.1371/A2-2.12.1) Transmitter RF attack time**

*The transmitter RF attack time shall not exceed 1 ms after the TX-ON signal according to the following definition: the RF attack time is the time from TX-ON signal until the RF Power has reached 80% of the nominal (steady state) level (refer to Figure 4).*

##### **7.2.12.2 (M.1371/A2-2.12.2) Transmitter frequency stabilisation time**

*The transmitter frequency stabilisation time shall be  $\pm 1.0$  kHz within 1.0 ms after start of transmission.*

##### **7.2.12.3 (M.1371/A2-2.12.3) Transmitter RF release time**

*The transmitter RF power must be switched off within 1 ms from the termination of transmission.*

**7.2.12.4 (M.1371/A2-2.12.4) Switching time**

*The channel switching time shall be less than 25msec*

*The time taken to switch from transmit to receive conditions, and vice versa, shall not exceed the transmit attack or release time. It shall be possible to receive a message from the slot directly after or before own transmission.*

*The equipment shall not be able to transmit during channel switching operation.*

*The equipment is not required to transmit on the other AIS channel in the adjacent time slot.*

**7.2.13 (M.1371/A2-2.13) Transmitter power**

*[The power level shall be determined by the Link Management Entity (LME) of the Link Layer.]*

*Provision shall be made for two levels of nominal power (high power, low power) as required by some applications. The default operation of the transponder shall be on the high nominal power level. Changes to the power level shall be by assignment only from the "Channel Management" Message 22.*

*The nominal levels for the two power settings shall be 2 W and 12.5 W. Tolerance shall be within  $\pm 20\%$ .*

**7.2.14 (M.1371/A2-2.14) Shutdown procedure**

*An automatic transmitter hardware shutdown procedure and indication shall be provided in case a transmitter does not discontinue its transmission within 0.5 seconds of the end of its transmission slot.*

**7.2.15 (M.1371/A2-2.14) Safety precautions**

*The AIS installation, when operating, shall not be damaged by the effects of open circuited or short circuited antenna terminals.*

### 7.3 Link layer

The Link layer specifies how data shall be packaged in order to apply error detection and correction to the data transfer. The Link layer is divided into three (3) sublayers.

#### 7.4 (M.1371/A2-3.1) Link sublayer 1: Medium Access Control (MAC)

The MAC sublayer provides a method for granting access to the data transfer medium, i.e. the VHF data link. The method used shall be a Time Division Multiple Access (TDMA) scheme using a common time reference.

##### 7.4.1 (M.1371/A2-3.1.1) TDMA synchronisation

TDMA synchronisation shall be achieved using an algorithm based on a synchronisation state as described below. The Sync State Flag within SOTDMA Communication State (refer to 7.6.7.2.2) and within ITDMA Communication State (refer to 7.6.7.3.2), indicates the synchronisation state of a station.

Parameters for TDMA synchronisation are described in Table 8 .

**Table 8**

Symbol	Parameter Name/Description	Nominal
MAC. Sync Base Rate	Sync Support Increased Update Rate (Base Station)	once per 3 sec
MAC. Sync Mobile Rate	Sync Support Increased Update Rate (Mobile Station)	once per 2 sec

##### 7.4.1.1 (M.1371/A2-3.1.1.1) UTC Direct Synchronisation

A station, which has direct access to UTC timing with the required accuracy shall indicate this by setting its synchronisation state to UTC Direct.

##### 7.4.1.2 (M.1371/A2-3.1.1.2) UTC Indirect Synchronisation

A station, which is unable to get direct access to UTC, but can receive other stations which indicate UTC Direct, shall synchronise to those stations. It shall then change its synchronisation state to UTC Indirect. This state shall be correct for any number of levels of indirect synchronisation.

##### 7.4.1.3 (M.1371/A2-3.1.1.3) Synchronised to base station (Direct or Indirect)

Mobile stations, which are unable to attain Direct or Indirect UTC synchronisation, but are able to receive transmissions from base stations, shall synchronise to the base station which indicates the highest number of received stations. The number of received stations shall be contained within the SOTDMA Communication State-Sub Message on the occasion that the parameter SlotTimeOut of the SOTDMA Communication State has the value three (3). The station which is thus synchronised to a Base Station shall then change its synchronisation state to "base station" to reflect this. This state shall be correct for any number of levels of indirect access to the base station.

When a station is receiving several other base stations which indicate the same number of received stations, synchronisation shall be based on the station with the lowest MMSI.

##### 7.4.1.4 (M.1371/A2-3.1.1.4) Synchronised to a semaphore station

A station, which is unable to attain UTC Direct or UTC Indirect synchronisation and is also unable to receive transmissions from a base station, shall synchronise to the station indicating the highest number of other stations received. This station shall then change its synchronisation state to "Number of Received Stations" (refer to 7.6.7.2.2 for SOTDMA Communication State and to 7.6.7.3.2 for ITDMA Communication State). When a station is receiving several other stations, which indicate

*the same number of received stations, synchronisation shall be based on the station with the lowest MMSI. That station becomes the semaphore on which synchronisation shall be performed.*

#### **7.4.2 (M.1371/A2-3.1.2) Time division**

*The system uses the concept of a frame. A frame equals one (1) minute and shall be divided into 2,250 slots. Access to the data link shall be, by default, given at the start of a slot. The frame start and stop coincide with the UTC minute, when UTC is available. When UTC is unavailable the procedure, described below shall apply.*

#### **7.4.3 (M.1371/A2-3.1.3) Slot phase and frame synchronisation**

##### **7.4.3.1 (M.1371/A2-3.1.3.1) Slot phase synchronisation**

*Slot Phase Synchronisation shall be by the method whereby one station uses the messages from other stations or base stations to re-synchronise itself, thereby maintaining a high level of synchronisation stability, and ensuring no message boundary overlapping or corruption of messages.*

*Decision to slot phase synchronise shall be made after receipt of end flag and valid frame check sequence (FCS). (State T3, Figure 7). At T5, the station resets its Slot Phase Synchronisation Timer, based on Ts, T3 and T5 (Figure 7).*

##### **7.4.3.2 (M.1371/A2-3.1.3.2) Frame synchronisation**

*Frame Synchronisation is the method whereby one station uses the current slot number of another station or base station, adopting the received slot number as its own current slot number. The current slot number of a received station is contained within the SOTDMA Communication State – Sub Message on the occasion that the parameter SlotTimeOut of the SOTDMA Communication State has the value two (2).*

### 7.4.3.3 (M.1371/A2-3.1.3.3) Synchronisation - Transmitting stations

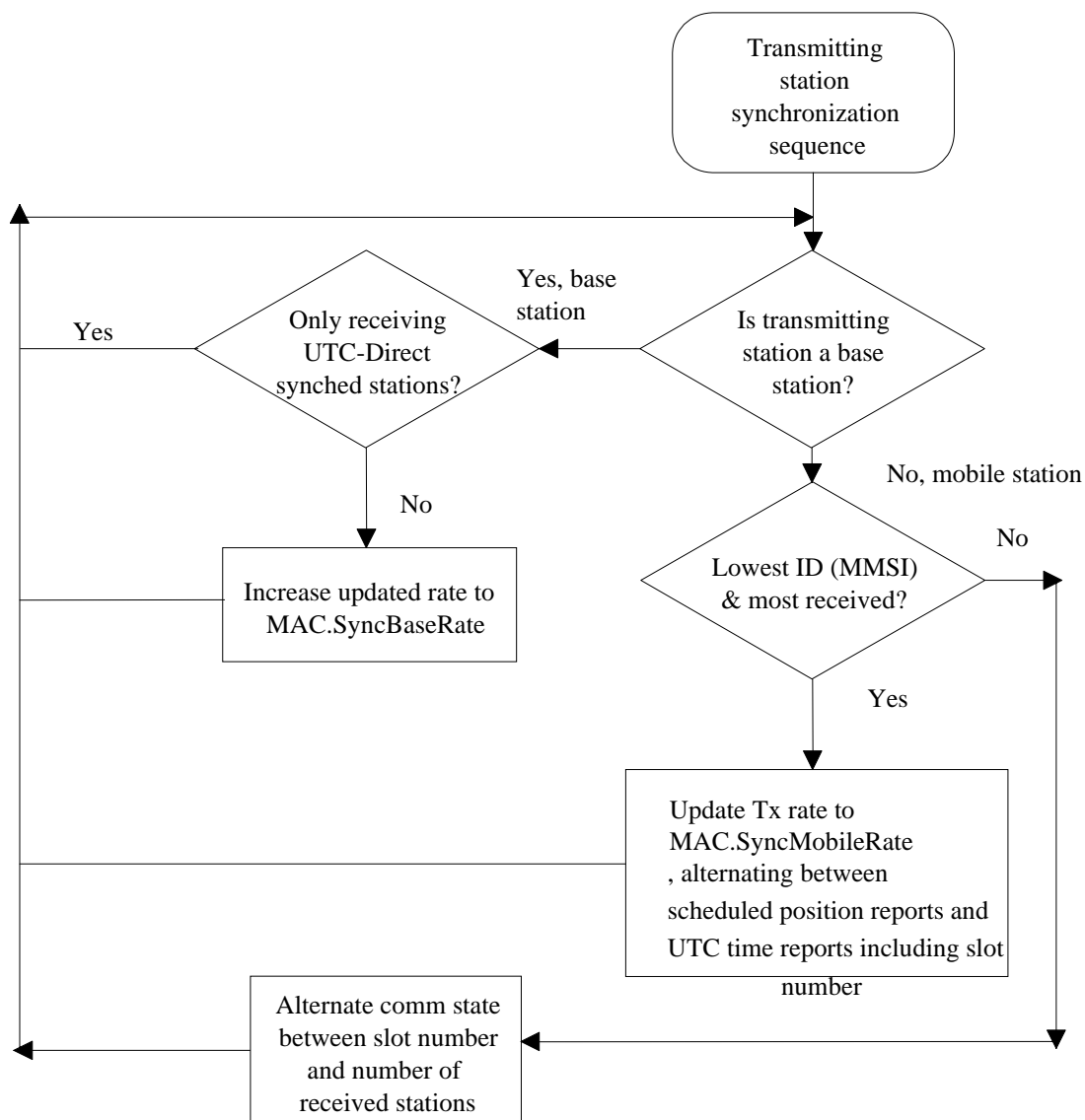


Figure 2

#### 7.4.3.3.1 (M.1371/A2-3.1.3.3.1)

#### Base station operation

The base station shall normally transmit the Base Station Report (Message 4) once per minute.

The base station shall operate in this state until it detects one or more stations which are lacking UTC direct synchronisation. It shall then increase its update rate of Message 4 to MAC. Sync Base Rate. It shall remain in this state until all stations are UTC Direct synchronised.

#### 7.4.3.3.2 (M.1371/A2-3.1.3.3.2)

#### Mobile station operation

When a mobile station determines that it is the semaphore (see 7.4.1.4), it shall increase its update rate to MAC. Sync Mobile Rate. When UTC is available, it shall also alternate its transmissions between the Position Report (Message 1) and the UTC/Date Response (Message 11).

### 7.4.3.4 (M.1371/A2-3.1.3.4) Synchronisation - Receiving stations

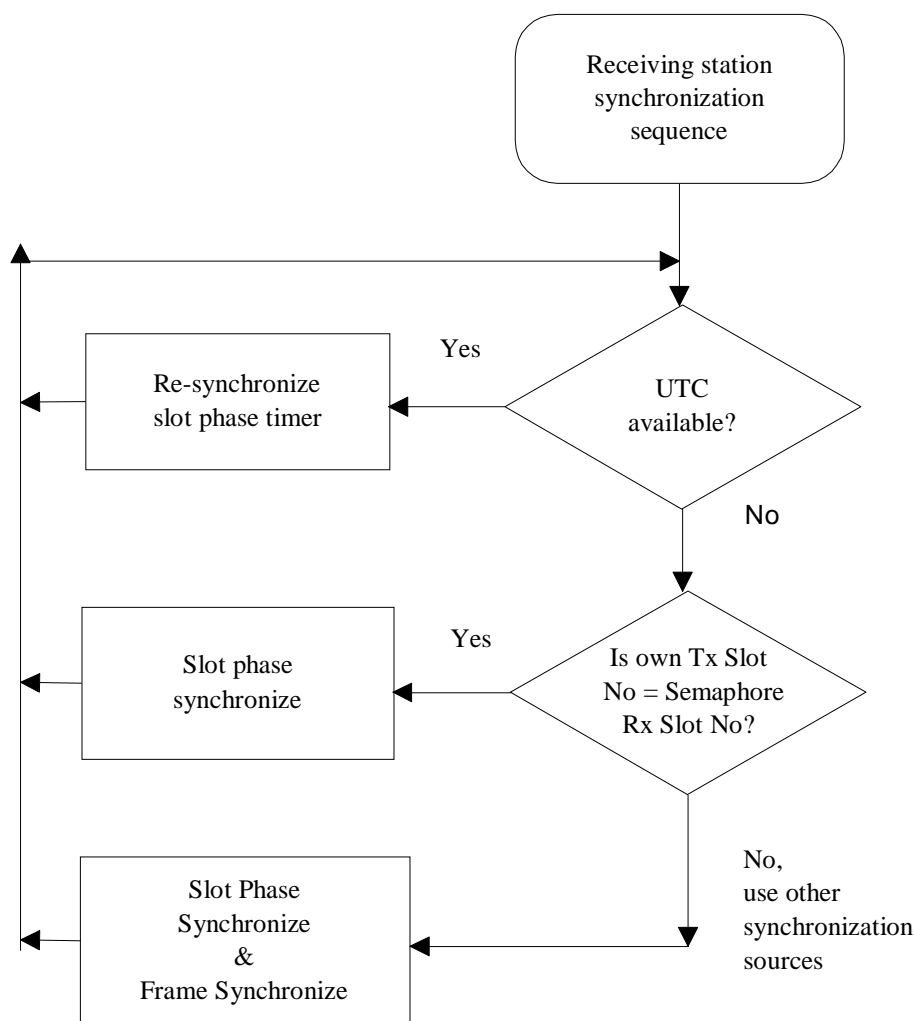


Figure 3

#### 7.4.3.4.1 (M.1371/A2-3.1.3.4.1) UTC available

A station, which has direct or indirect access to UTC, shall continuously re-synchronise its transmissions based on the UTC source.

#### 7.4.3.4.2 (M.1371/A2-3.1.3.4.2) Slot number equal to semaphore slot number

When the station determines that its own internal slot number is equal to the received semaphore slot number, it is already in Frame Synchronisation and it shall continuously Slot Phase synchronise.

#### 7.4.3.4.3 (M.1371/A2-3.1.3.4.3) Other synchronisation sources

Other possible synchronisation sources, which can serve as a basis for Slot Phase and Frame Synchronizations, are listed below in order of priority:

- 1) A station which has UTC time;
- 2) A base station which is semaphore qualified;
- 3) Other station(s) which are synchronised to a base station;
- 4) A mobile station, which is semaphore qualified.

See 7.4.1.4 for semaphore qualification. A station shall be semaphore qualified if it is indicating the most number of received stations. If more than one indicate the same amount, the one with the lowest identifier rules. The station with the highest sync state can also be semaphore qualified if that is the sole station with that sync state.

#### 7.4.4 (M.1371/A2-3.1.4) Slot identification

Each slot shall be identified by its index (0-2249). Slot zero (0) shall be defined as the start of the frame.

#### 7.4.5 (M.1371/A2-3.1.5) Slot access

The transmitter shall begin transmission by turning on the RF power at slot start. The transmitter shall be turned off after the last bit of the transmission packet has left the transmitting unit. This event must occur within the slots allocated for own transmission. The default length of a transmission occupies one (1) slot. The slot access shall be performed as shown in Figure 4:

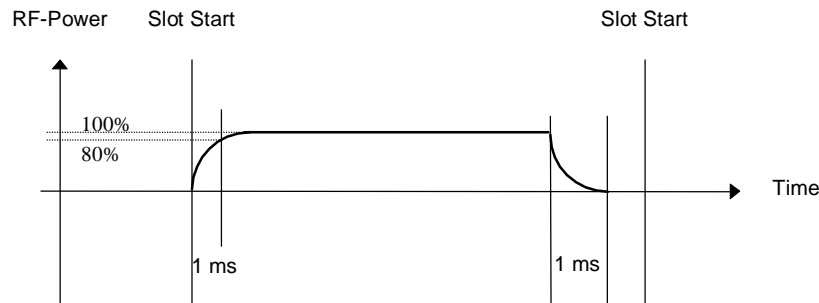


Figure 4

#### 7.4.6 (M.1371/A2-3.1.6) Slot state

Each slot can be in one of the following states:

- 1) FREE: meaning that the slot is unused within the receiving range of the own station. This slot may be considered as a candidate slot for use by own station (refer to 7.6.1.2);
- 2) INTERNAL ALLOCATION: meaning that the slot is allocated by own station and can be used for transmission;
- 3) EXTERNAL ALLOCATION: meaning that the slot is allocated for transmission by another station and cannot be used by own station;
- 4) AVAILABLE: meaning that the slot is externally allocated by a distant station and is a possible candidate for slot reuse (refer to 7.7.4.1).

### 7.5 (M.1371/A2-3.2) Link sublayer 2: Data Link Service (DLS)

The DLS sublayer provides methods for:

- 1) data link activation and release;
- 2) data transfer; or
- 3) error detection and control.

#### 7.5.1 (M.1371/A2-3.2.1) Data link activation and release

Based on the MAC sublayer the DLS shall listen, activate or release the data link. Activation and release shall be done in accordance with section 7.4.5 above. A slot, marked as free or externally allocated, indicates that own equipment shall be in receive mode and listen for other data link users. This shall also be the case with slots, marked as available and not to be used by own station for transmission (refer to 7.7.4.1)

#### 7.5.2 (M.1371/A2-3.2.2) Data transfer

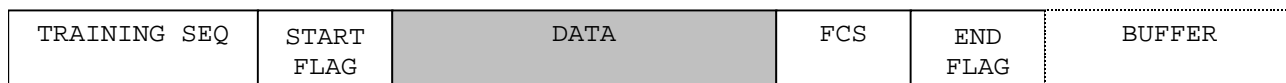
Data transfer shall use a bit-oriented protocol which shall be based on the High-Level Data Link Control (HDLC) as specified by ISO/IEC 3309, 1993- definition of packet structure. Information packets (I-Packets) shall be used with the exception that the control field is omitted (see Figure 5).

### 7.5.2.1 (M.1371/A2-3.2.2.1) Bit stuffing

The bit stream shall be subject to bit stuffing. This means that if five (5) consecutive ones (1s) are found in the output bit stream, a zero shall be inserted. This applies to all bits except the data bits of HDLC flags (Start flag and End flag, see Figure 5).

### 7.5.2.2 (M.1371/A2-3.2.2.2) Packet format

Data shall be transferred in a broadcast mode using a transmission packet as shown in Figure 5:

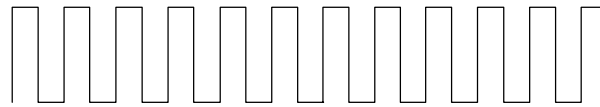


**Figure 5**

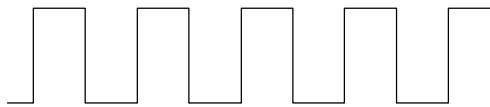
The packet *shall* be sent from left to right. This structure is identical to the general HDLC structure, except for the training sequence. The training sequence *shall* be used in order to synchronise the VHF receiver and is discussed in 7.5.2.3. The total length of the default packet *shall* be 256 bits. This is equivalent to one (1) slot.

### 7.5.2.3 (M.1371/A2-3.2.2.3) Training sequence

*The training sequence shall be a bit pattern consisting of alternating 0s and 1s (010101010...). Twenty four bits of preamble shall be transmitted prior to sending the flag (unless a 32- bit training sequence is assigned, see paragraph 7.2.6). This bit pattern shall be modified due to the NRZI mode used by the communication circuit. See Figure 6.*



**a) Unmodified bit pattern**



**b) Modified bit pattern by NRZI**

### Figure 6

*The preamble shall not be subject to bit stuffing.*

#### 7.5.2.4 (M.1371/A2-3.2.2.4) Start flag

*The start flag shall be 8 bits long and consists of a standard HDLC flag. It shall be used in order to detect the start of a transmission packet. The Start flag consists of a bit pattern, 8 bits long: 01111110 (7Eh). The flag shall not be subject to bit stuffing, although it consists of 6 bits of consecutive ones (1s).*

#### 7.5.2.5 (M.1371/A2-3.2.2.5) Data

*The data portion shall be 168 bits long in the default transmission packet. The content of data shall be undefined at the DLS. Transmission of data, which occupy more than 168 bits, is described in 7.5.2.11 below.*

#### 7.5.2.6 (M.1371/A2-3.2.2.6) FCS

The FCS (Frame Check Sequence) uses the Cyclic Redundancy Check (CRC) 16- bit polynomial to calculate the checksum as defined in ISO/IEC 3309: 1993. The CRC bits shall be pre-set to one (1) at the beginning of a CRC calculation. Only the data portion, including bit stuffing, shall be included in the CRC calculation (see Figure 5).

#### 7.5.2.7 (M.1371/A2-3.2.2.7) End flag

*The end flag shall be identical to the Start flag as described in 7.5.2.4.*

#### 7.5.2.8 (M.1371/A2-3.2.2.8) Buffering

*The buffering shall be normally 24 bits long and shall be used as follows:*

- *bit stuffing*                      4 bits (normally, for all messages except Safety Related Messages and Binary Messages)
- *distance delay*                    12 bits
- *repeater delay*                    2 bits

- synchronisation jitter 6 bits

#### 7.5.2.8.1 (M.1371/A2-3.2.2.8.1) Bit stuffing

A statistical analysis of all possible bit combinations in the data field shows that 76% of combinations use 3 bits or less, for bit stuffing. Adding the logically possible bit combinations shows that 4 bits are sufficient for virtually all messages. Where variable message length messages are used, additional bit stuffing could be required. For the case where additional bit stuffing is required, refer to 7.8.3.2 .

#### 7.5.2.8.2 (M.1371/A2-3.2.2.8.2) Distance delay

A buffer value of 12 bits shall be reserved for distance delay. This is equivalent to 202.16 nautical miles (nm). This distance delay provides protection for a propagation range of over 100 nm.

#### 7.5.2.8.3 (M.1371/A2-3.2.2.8.3) Repeater delay

The repeater delay provides for a turn-around time in a duplex repeater.

#### 7.5.2.8.4 (M.1371/A2-3.2.2.8.4) Synchronisation jitter

The synchronisation jitter bits preserve integrity on the TDMA data link, by allowing a jitter in each time slot, which is equivalent to  $\pm 3$  bits. Transmission timing error shall be within  $\pm 104 \mu\text{s}$  of the synchronisation source. Since timing errors are additive, the accumulated timing error can be as much as  $\pm 312 \mu\text{s}$ .

#### 7.5.2.9 (M.1371/A2-3.2.2.9) Summary of the default transmission packet

The data packet is summarised as shown in Table 9 below:

Table 9

Ramp Up	8 bits	T0 to T1 in Figure 6
Training Sequence	24 bits	Necessary for synchronisation
Start Flag	8 bits	In accordance with HDLC (7Eh).
Data	168 bits	Default
CRC	16 bits	In accordance with HDLC.
End Flag	8 bits	In accordance with HDLC (7Eh).
Buffering	24 bits	Bit stuffing distance delays, repeater delay and jitter
Total	256 bits	

#### 7.5.2.10 (M.1371/A2-3.2.2.10) Transmission timing

Figure 7 shows the timing events of the default transmission packet (one slot). At the situation where the ramp down of the RF power overshoots into the next slot, there shall be no modulation of the RF after the termination of transmission. This prevents undesired interference, due to false locking of receiver modems, with the succeeding transmission in the next slot.

## Transmission timing

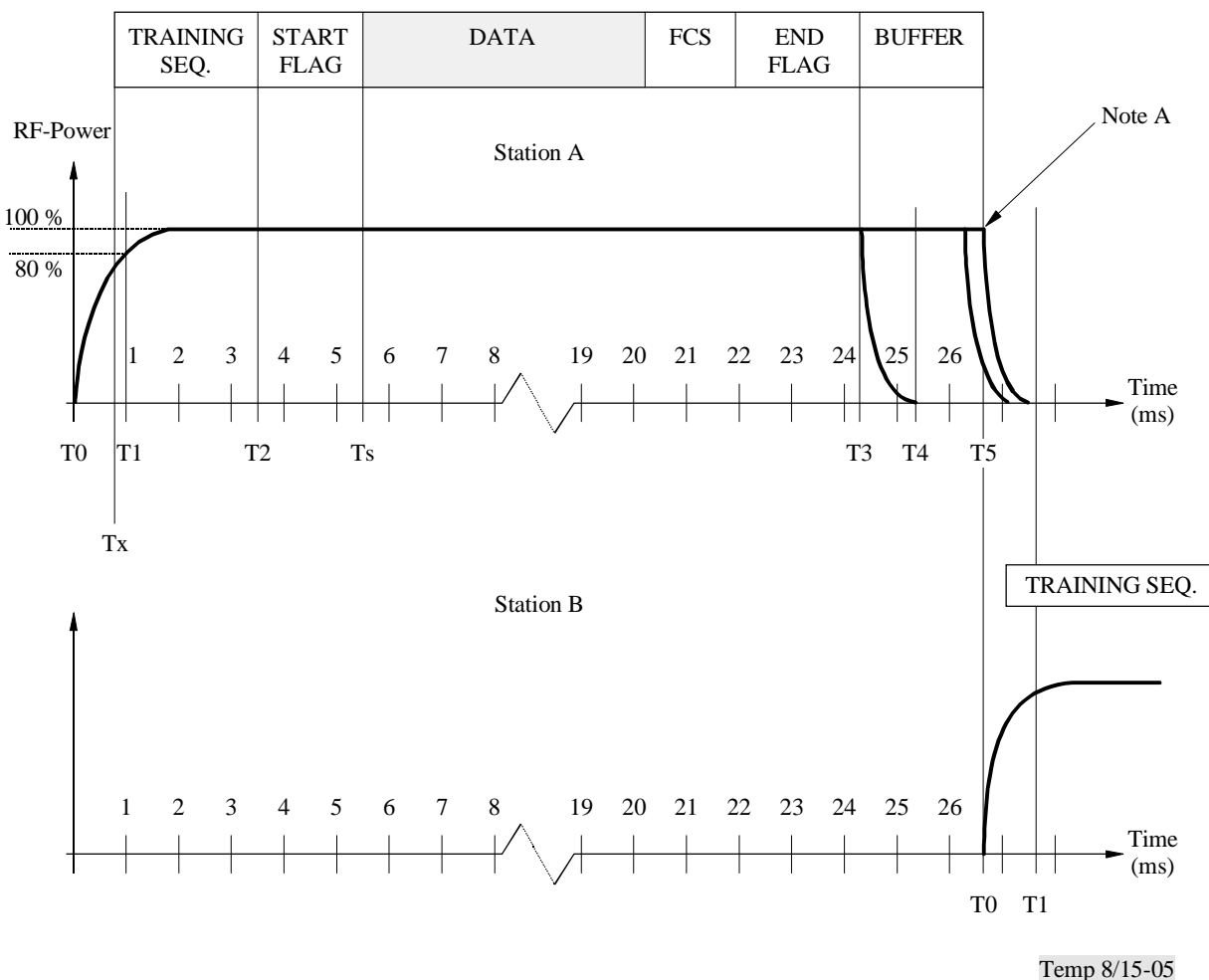


Figure 7

Table 10

<i>T(n)</i>	<i>Time (ms)</i>	<i>Description</i>
<i>T0</i>	0.000	Slot start. RF power is applied (TX-ON).
<i>Tx</i>	0.832	Beginning of training sequence.
<i>T1</i>	1.000	RF power and frequency stabilisation time.
<i>T2</i>	3.328	Start of transmission packet (Start flag). This event can be used as a secondary synchronisation source should the primary source (UTC) be lost.
<i>Ts</i>	4.160	Slot Phase Synchronise Marker. End of start flag, beginning of data.
<i>T3</i>	24.128	End of transmission, assuming zero bit stuffing. No modulation is applied during TX-OFF. In case of a shorter data block, the transmission may end earlier.
<i>T4</i>	<i>T3</i> + 1.000	The time when RF power Shall have reached zero.
<i>T5</i>	26.670	End of slot. Beginning of next slot.

NOTE 1 –Should a transmission end exactly at the beginning of the next slot, the TX-down period for station A will overlap into the next slot as shown in Figure 7. Transmission of the training sequence shall not be impaired by this. This occasion would be extremely rare due to the large buffer and it would occur only in the event of a propagation anomaly. Even in this case, the operation of the AIS shall be not impaired due to the range discrimination characteristics of the receiver.

#### 7.5.2.11 (M.1371/A2-3.2.2.11) Long transmission packets

A station may occupy at maximum five consecutive slots for one (1) continuous transmission. Only a single application of the overhead (ramp up, training sequence, flags, FCS, buffering) is required for

a long transmission packet. The length of a long transmission packet shall not be longer than necessary to transfer the data, i. e. the AIS shall not add filler.

### 7.5.3 (M.1371/A2-3.2.3) Error detection and control

Error detection and control shall be handled using the CRC polynomial as described in 7.5.2.6. CRC errors shall result in no further action by the AIS.

## 7.6 (M.1371/A2-3.3) Link sublayer 3 - Link Management Entity (LME)

The LME controls the operation of the DLS, MAC and the physical layer.

### 7.6.1 (M.1371/A2-3.3.1) Access to the data link

There shall be four different access schemes for controlling access to the data transfer medium. The application and mode of operation determine the access scheme to be used. The access schemes are:

- Self Organised Time Division Multiple Access (SOTDMA),
- Incremental Time Division Multiple Access (ITDMA),
- Random Access Time Division Multiple Access (RATDMA) and
- Fixed Access Time Division Multiple Access (FATDMA).

SOTDMA is the basic scheme used for scheduled repetitive transmissions from an autonomous station. When, for example, the update rate has to be changed, or a non-repetitive message is to be transmitted, other access schemes may be used.

#### 7.6.1.1 (M.1371/A2-3.3.1.1) Cooperation on the data link

The access schemes operate continuously, and in parallel, on the same physical data link. They all conform to the rules set up by the TDMA (as described in 7.2.1.5).

#### 7.6.1.2 (M.1371/A2-3.3.1.2) Candidate slots

Slots, used for transmission, shall be selected from candidate slots in the selection interval (SI), refer to Figure 8. There shall always be at minimum four candidate slots to choose from. The candidate slots are primarily selected from free slots (see section 7.4.5). When required, available slots shall be included in the candidate slot set. When selecting a slot from the candidates, any candidate has the same probability of being chosen, regardless of its slot state (refer to 7.4.6).

When selecting among candidate slots for transmission in one channel, the slot usage of other channels shall be considered. If the candidate slot in the other channel is used by another station, the use of the slot shall follow the same rules as for slot reuse (refer to 7.7.4.1). If a slot in either channel is occupied by or allocated by other base or mobile station, that slot shall be reused only in accordance with 7.7.4.1.

The own station is unable to transmit on an adjacent slot on the two parallel channels because of the necessary switching time (refer to 7.2.12.4). Thus, the two adjacent slots on either side of a slot that is being used by the own station on one channel shall not be considered as candidate slots on the other channel.

The purpose for intentionally reusing slots and maintaining a minimum of four candidate slots within the same probability of being used for transmission is to provide high probability of access to the link. To further provide high probability of access, timeout characteristics are applied to the use of the slots so that slots will continuously become available for new use.

Figure 8 illustrates the process of selecting among candidate slots for transmission on the link.

Selecting candidate slots

No

**Figure 8**

#### **7.6.2 (M.1371/A2-3.3.2) Modes of operation**

*There shall be three modes of operation. The default mode shall be autonomous and may be switched to/from other modes as required by a competent authority.*

##### **7.6.2.1 (M.1371/A2-3.3.2.1) Autonomous and continuous**

*A station operating autonomously shall determine its own schedule for transmission of its position. The station shall automatically resolve scheduling conflicts with other stations.*

##### **7.6.2.2 (M.1371/A2-3.3.2.2) Assigned**

*A station operating in the assigned mode shall use a transmission schedule assigned by a competent authority's base or repeater station.*

##### **7.6.2.3 (M.1371/A2-3.3.2.3) Polled**

*A station operating in polled mode shall automatically respond to Interrogation messages (Message 15) from a ship or competent authority. Operation in the polled mode shall not conflict with operation in the other two modes. The response shall be transmitted on the channel where the Interrogation message was received.*

#### **7.6.3 (M.1371/A2-3.3.3) Initialisation**

*At power on, a station shall monitor the TDMA channels for one (1) minute to determine channel activity, other participating member IDs, current slot assignments and reported positions of other users, and possible existence of shore stations. During this time period, a dynamic directory of all stations operating in the system shall be established. A frame map shall be constructed, which reflects TDMA channel activity. After one (1) minute has elapsed, the station shall enter the operational mode and start to transmit according to its own schedule.*

#### **7.6.4 (M.1371/A2-3.3.4) Channel access schemes**

*The access schemes, as defined below, shall co-exist and operate simultaneously on the TDMA channel.*

#### 7.6.4.1 (M.1371/A2-3.3.4.1) Incremental TDMA - ITDMA

The ITDMA access scheme allows a station to pre-announce transmission slots of non-repeatable character, with one exception: During data link network entry, ITDMA slots shall be marked so that they are reserved for one additional frame. This allows a station to pre-announce its allocations for autonomous and continuous operation.

ITDMA shall be used on three occasions:

- 1) Data link network entry,
- 2) Temporary changes and transitions in periodical report rates,
- 3) Pre-announcement of safety related messages.

##### 7.6.4.1.1 (M.1371/A2-3.3.4.1.1) ITDMA access algorithm

A station can begin its ITDMA transmission by either substituting a SOTDMA allocated slot or, by allocating a new, unannounced slot, using RATDMA. Either way, this becomes the first ITDMA slot.

The first transmission slot, during data link network entry, shall be allocated using RATDMA. That slot shall then be used as the first ITDMA transmission.

When above layers dictate a temporary change of report rate or the need to transmit a safety related message, the next scheduled SOTDMA slot may pre-emptively be used for an ITDMA transmission.

Prior to transmitting in the first ITDMA slot, the station randomly selects the next following ITDMA slot and calculates the relative offset to that location. This offset shall be inserted into the ITDMA Communication State. Receiving stations will be able to mark the slot, indicated by this offset, as "externally allocated" (refer to 7.6.7.3.2 and 7.4.5). The Communication State is transmitted as a part of the ITDMA transmission. During network entry, the station also indicates that the ITDMA slots shall be reserved for one additional frame. The process of allocating slots, continues as long as required. In the last ITDMA slot, the relative offset shall be set to zero.

##### 7.6.4.1.2 (M.1371/A2-3.3.4.1.2) ITDMA parameters

The following parameters control ITDMA scheduling:

**Table 11**

Symbol	Name	Description	Min	Max
LME.ITINC	Slot Increment	The slot increment is used to allocate a slot ahead in the frame. It is a relative offset from the current transmission slot. If it is set to zero, no more ITDMA allocations shall be done.	0	8191
LME.ITSL	Slots	Indicates the number of consecutive slots, which are allocated, starting at the slot increment.	1	5
LME.ITKP	Keep Flag	This flag shall be set to TRUE when the slot(s), allocated ahead in the frame, and shall be reserved for the next frame also. The keep flag is set to FALSE when the allocated slot*** and shall be freed immediately after transmission.	FALSE	TRUE

#### 7.6.4.2 (M.1371/A2-3.3.4.2) Random Access TDMA - RATDMA

RATDMA shall be used when a station needs to allocate a slot, which has not been pre-announced. This shall be generally done for the first transmission slot during data link network entry, or for messages of a non-repeatable character.

##### 7.6.4.2.1 (M.1371/A2-3.3.4.2.1) RATDMA algorithm

The RATDMA access scheme shall use a probability persistent (P-Persistent) algorithm as described in this paragraph (refer to Table 12).

Messages, which use the RATDMA access scheme, shall be stored in a priority FIFO. When a candidate slot (a slot which is marked available for use) is detected, the station randomly select a probability value (LME.RTP1) between 0 and 100. This value shall be compared with the current probability for transmission (LME.RTP2). If LME.RTP1 is equal to, or less than LME.RTP2, transmission shall occur in the candidate slot. If not, LME.RTP2 shall be incremented with a probability increment (LME.RTPi) and the station shall wait for the next candidate slot in the frame.

The Selection Interval (SI) for RATDMA shall be 150 time slots, which is equivalent to 4 seconds. The candidate slot set shall be chosen within the SI, so that the transmission occurs within 4 seconds.

#### 7.6.4.2.2 (M.1371/A2-3.3.4.2.2) RATDMA parameters

The following parameters control RATDMA scheduling:

**Table 12**

Symbol	Name	Description	Min	Max
LME.RTPRI	Priority	The priority that the transmission has when queuing messages. The priority is highest, when LME.RTPRI is lowest. Safety related messages shall have highest service priority (refer 7.7.2.3).	1	0
LME.RTPS	Start Probability	Each time a new message is due for transmission, LME.RTP2 shall be set equal to LME.RTPS	10	20
LME.RTP1	Derived Probability	Calculated probability for transmission in the next candidate slot. It shall be less than or equal to LME.RTP2 for transmission to occur, and it shall be randomly selected for each transmission attempt.	0	100
LME.RTP2	Current Probability	The current probability that a transmission will occur in the next candidate slot.	LME.RTPS	100
LME.RTPi	Probability Increment	Each time the algorithm determines that transmission shall not occur, LME.RTP2 shall be incremented with LME.RTPi.	1	50

#### 7.6.4.3 (M.1371/A2-3.3.4.3) Fixed Access TDMA - FATDMA

FATDMA shall be used by base stations only. FATDMA allocated slots shall be used for repetitive messages. For base stations use of FATDMA refer to 7.7.6 and 7.7.7.

##### 7.6.4.3.1 (M.1371/A2-3.3.4.3.1) FATDMA algorithm

Access to the data link shall be achieved with reference to frame start. Each allocation shall be pre-configured by the competent authority, and not changed for the duration of the operation of the station or, until re-configured. Except where the time out value is otherwise determined, receivers of FATDMA messages shall set a timeout value of 3 minutes in order to determine when the FATDMA slot will become free. The 3 minute time out shall be reset with each reception of the message.

##### 7.6.4.3.2 (M.1371/A2-3.3.4.3.2) FATDMA parameters

The following parameters control FATDMA scheduling.

**Table 13**

Symbol	Name	Description	Min	Max
LME.FTST	Start Slot	The first slot (referenced to frame start) to be used by the station	0	2249
LME.FTI	Increment	Increment to next block of allocated slots. An increment of zero indicates that the station transmits one time per frame, in the start slot.	0	1125
LME.FTBS	Block Size	Default block size. Determines the default number of consecutive slots which are to be reserved at each increment	1	5

#### 7.6.4.4 (M.1371/A2-3.3.4.4) Self-Organising TDMA - SOTDMA

The SOTDMA access scheme shall be used by mobile stations operating in autonomous and continuous mode. The purpose of the access scheme is to offer an access algorithm which quickly resolves conflicts without intervention from controlling stations. Messages which use the SOTDMA access scheme are of a repeatable character and shall be used in order to supply a continuously updated surveillance picture to other users of the data link.

##### 7.6.4.4.1 (M.1371/A2-3.3.4.4.1) SOTDMA algorithm

The access algorithm and continuous operation of SOTDMA is described in the 0, autonomous and continuous operation, below.

##### 7.6.4.4.2 (M.1371/A2-3.3.4.4.2) SOTDMA parameters

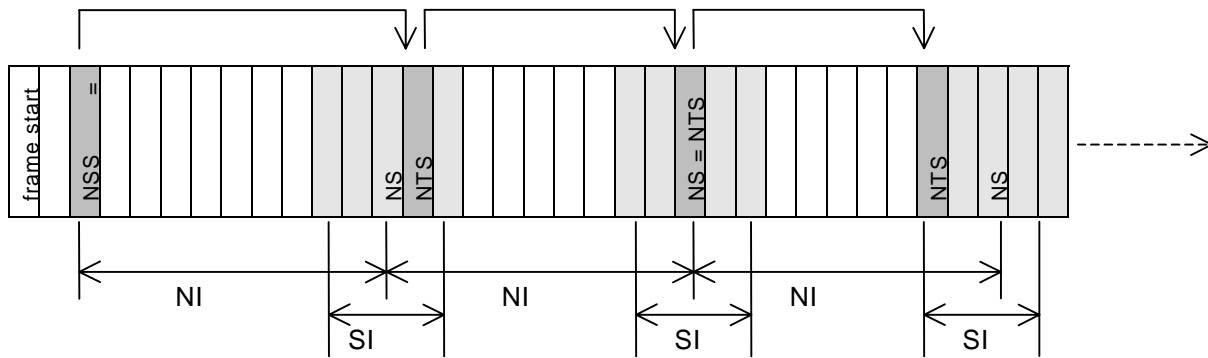
The following parameters control SOTDMA scheduling.

**Table 14**

Symbol	Name	Description	Min	Max
NSS	Nominal Start Slot	This shall be the first slot used by a station to announce itself on the data link. Other repeatable transmissions shall be generally selected with the NSS as a reference.	0	2249
NS	Nominal Slot	The nominal slot shall be used as the centre around which slots shall be selected for transmission of position reports. For the first transmission in a frame, the NSS and NS shall be equal. Any NS shall be derived using the equation below: $NS = NSS + (n * NI); (0 \leq n < Rr)$	0	2249
NI	Nominal Increment	The nominal increment shall be given in number of slots and is derived using the equation below: $NI = 2250 / Rr$	75	1225
RRr	Report Rate	shall be the desired number of position reports per frame. When a station uses a report rate of less than one report per frame, ITDMA allocations shall be used. Otherwise SOTDMA shall be used.	1/3	30
SI	Selection Interval	Selection Interval. The selection interval shall be the collection of slots which can be candidates for position reports. The SI shall be derived using the equation below: $SI = \{NS - (0.1 * NI) \text{ to } NS + (0.1 * NI)\}$	$0.2 * NI$	$0.2 * NI$
NTS	Nominal Transmission Slot	The NTS shall be the slot, within a selection interval, currently used for transmissions within that interval.	0	2249
TMO_MIN	Minimum time-out	The minimum number of frames that a SOTDMA allocation will occupy a specific slot.	3	3
TMO_MAX	Maximum time-out	The maximum number of frames that a SOTDMA allocation will occupy a specific slot.	TMO_MIN	8

#### 7.6.5 (M.1371/A2-3.3.5) Autonomous and continuous operation

This section describes how a station operates in the autonomous and continuous mode. Figure 9 shows the slot map accessed using SOTDMA.



NI	nominal increment	( = 2250 / reporting rate )
NSS	nominal start slot	(network entry)
NS	nominal slot	( = NSS + n * NI )
SI	selection interval	( = NS $\pm$ 0,1 * NI )
NTS	nominal transmission slot	(chosen from candidate slots within SI)
	slot offset	( = slot <sub>NTS+1</sub> – slot <sub>NTS</sub> )

Figure 9

#### 7.6.5.1 (M.1371/A2-3.3.5.1) Initialisation phase

The initialisation phase is described using the flowchart shown in Figure 10 .

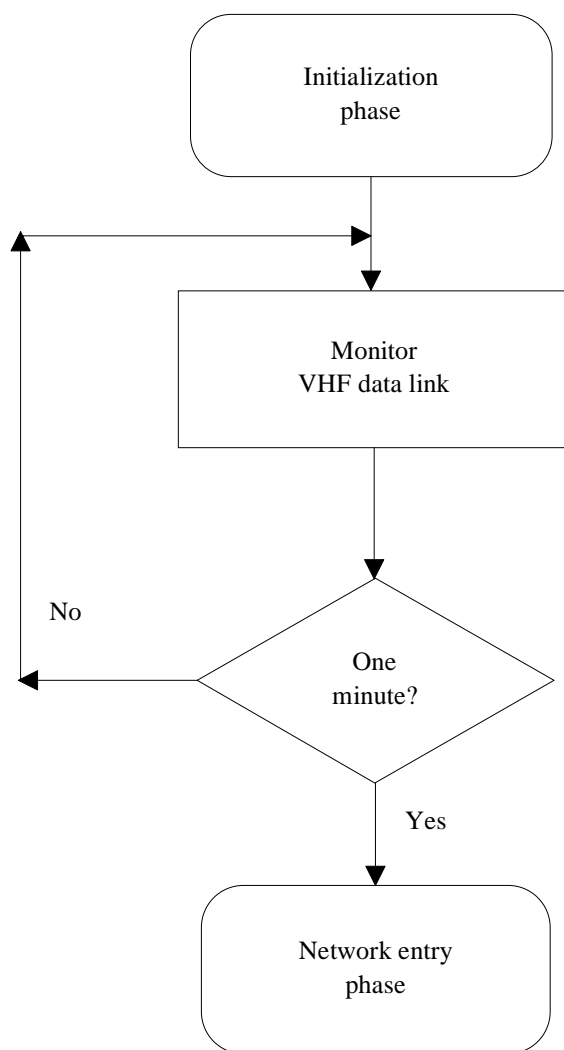


Figure 10

#### 7.6.5.1.1 (M.1371/A2-3.3.5.1.1) Monitor VHF data link (VDL)

*At power on, a station shall monitor the TDMA channel for one (1) minute to determine: channel activity, other participating member IDs, current slot assignments and reported positions of other users, and possible existence of base stations. During this time period, a dynamic directory of all members operating in the system shall be established. A frame map shall be constructed, which reflects TDMA channel activity.*

#### 7.6.5.1.2 (M.1371/A2-3.3.5.1.2) One minute

*After one (1) minute has elapsed, the station shall enter the network and start to transmit according to its own schedule, as described below.*

#### 7.6.5.2 (M.1371/A2-3.3.5.2) Network entry phase

During the network entry phase, the station *shall* select its first slot for transmission in order to make itself visible to other participating stations. The first transmission *shall* always be the scheduled position report (refer to Figure 11)

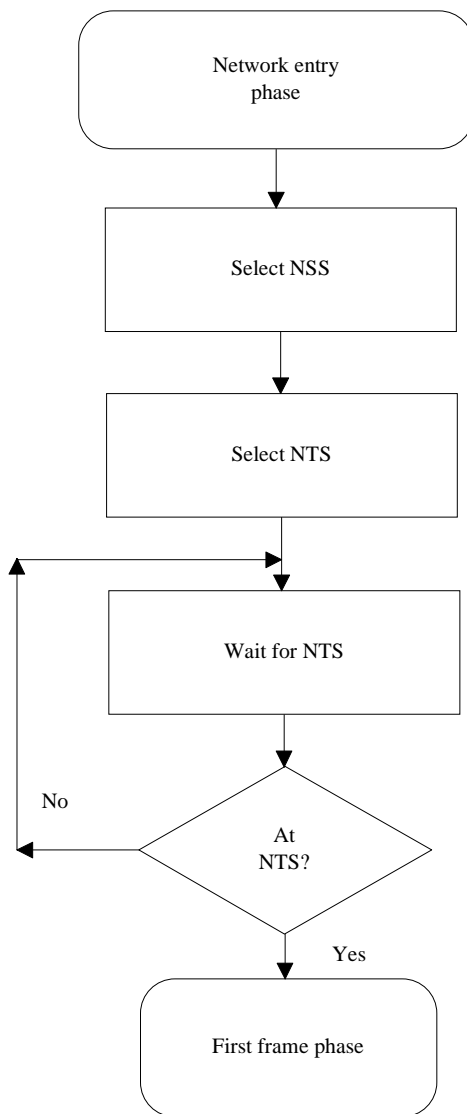


Figure 11

#### 7.6.5.2.1 (M.1371/A2-3.3.5.2.1) Select Nominal Start Slot (NSS)

The NSS shall be randomly selected between current slot and Nominal Increment (NI) slots forward. This slot shall be the reference when selecting Nominal Slots (NS) during the first frame phase. The first NS shall always be equal to NSS.

#### 7.6.5.2.2 (M.1371/A2-3.3.5.2.2) Select Nominal Transmission Slot (NTS)

Within the SOTDMA algorithm the NTS shall be randomly selected among candidate slots within the Selection Interval (SI). This is the NTS, which shall be marked as internally allocated and assigned a random time-out between TMO\_MIN and TMO\_MAX.

#### 7.6.5.2.3 (M.1371/A2-3.3.5.2.3) Wait for NTS

The station shall wait until the NTS is approached.

#### 7.6.5.2.4 (M.1371/A2-3.3.5.2.4) At NTS

When the frame map indicates that the NTS is approaching, the station shall enter the First Frame Phase.

### 7.6.5.3 (M.1371/A2-3.3.5.3) First frame phase

During the first frame phase, the station shall continuously allocate its transmission slots and transmit scheduled position reports using ITDMA (refer Figure 12).

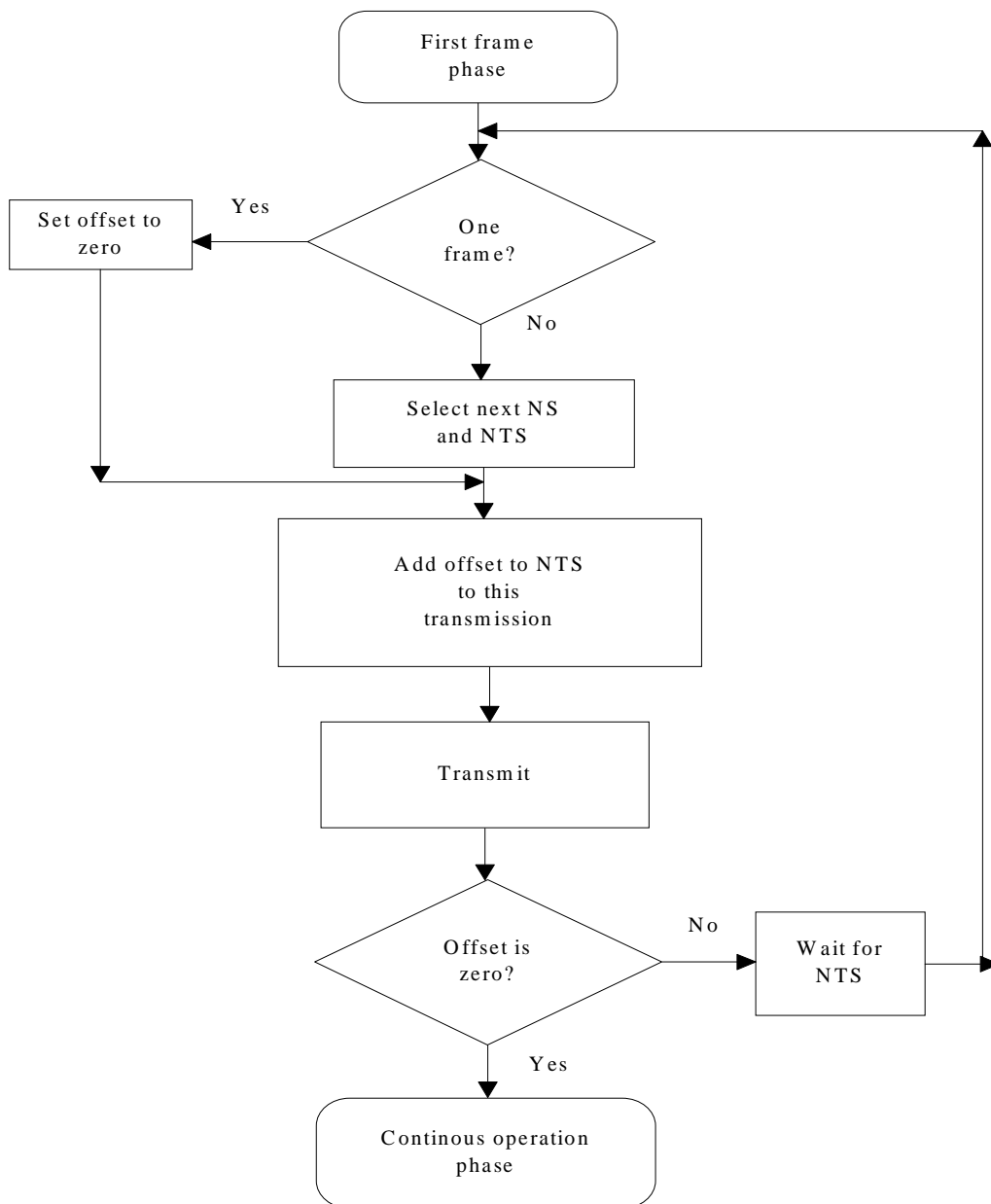


Figure 12

#### 7.6.5.3.1 (M.1371/A2-3.3.5.3.1) One frame

When one frame has elapsed, the initial transmissions shall have been allocated and nominal operation shall commence.

#### 7.6.5.3.2 (M.1371/A2-3.3.5.3.2) Set offset to zero

The offset shall be used in the first frame when all transmissions use the ITDMA access scheme. The offset indicates the relative distance from the current transmission to next intended transmission. It is an incremental update of the intention of the station.

**7.6.5.3.3 (M.1371/A2-3.3.5.3.3) Select next NS and NTS**

*Prior to transmitting, the next NS shall be selected. This shall be done by keeping track of the number of transmissions performed so far (from  $n$  to  $R_r - 1$ ). The NS shall be selected using the equation described in Table 9.*

*Nominal transmission slot shall be selected using the SOTDMA algorithm to select among candidate slots within SI. The NTS shall then be marked as internally allocated. The offset to next NTS shall be calculated and saved for the next step.*

**7.6.5.3.4 (M.1371/A2-3.3.5.3.4) Add offset to this transmission**

*All transmissions in the first frame phase shall use the ITDMA access scheme. This structure contains an offset from the current transmission to the next slot in which a transmission is due to occur. The transmission also sets the keep flag so that receiving stations will allocate the slot for one additional frame.*

**7.6.5.3.5 (M.1371/A2-3.3.5.3.5) Transmit**

*A scheduled position report shall be entered into the ITDMA packet and transmitted in the allocated slot. The Slot Time-Out of this slot shall be decremented by one.*

**7.6.5.3.6 (M.1371/A2-3.3.5.3.6) Offset is zero**

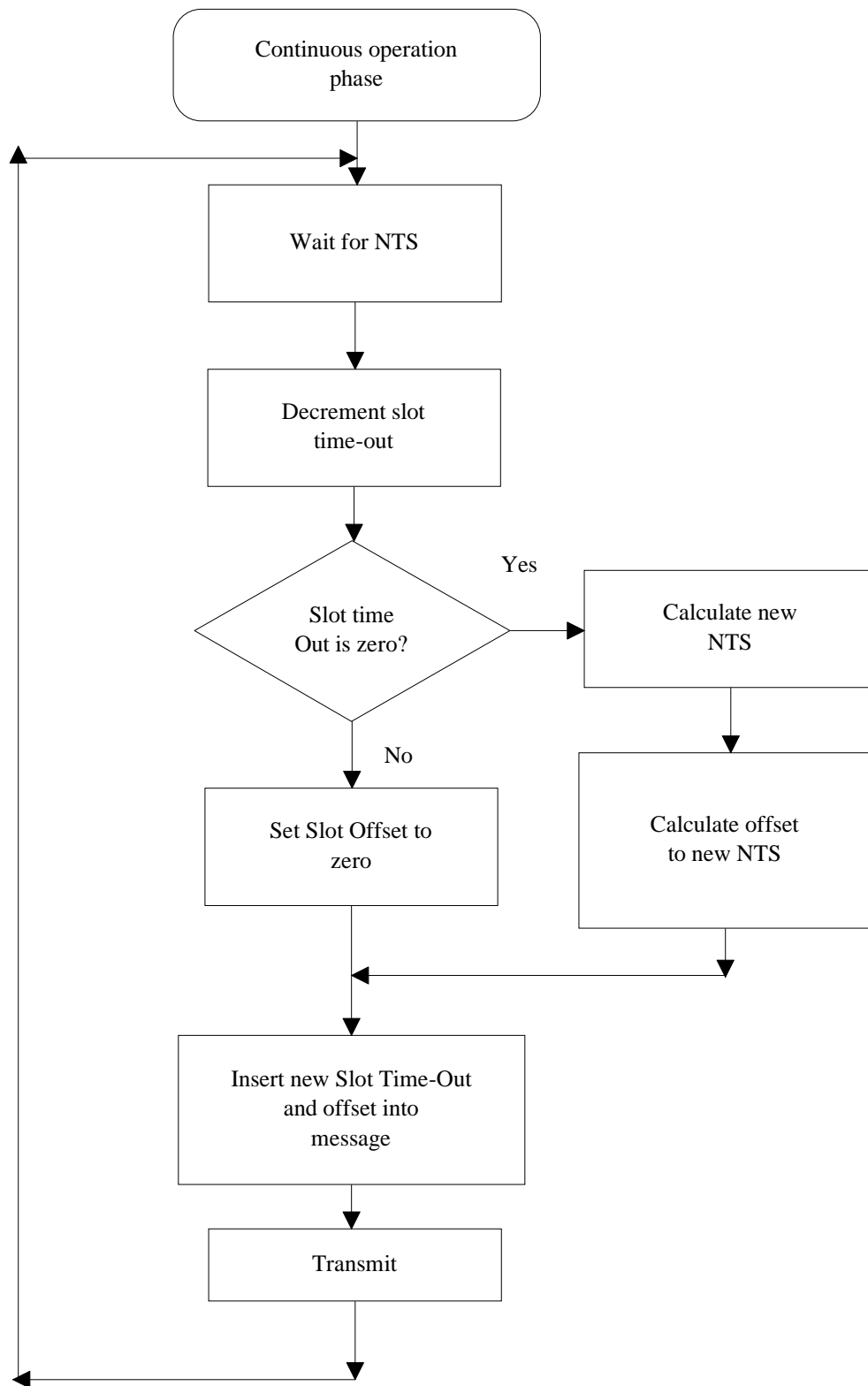
*If the offset has been set to zero, the first frame phase shall be considered to have ended. The station shall now enter the continuous operation phase.*

**7.6.5.3.7 (M.1371/A2-3.3.5.3.7) Wait for NTS**

*If the offset was non-zero, the station shall wait for the next NTS and repeat the sequence.*

**7.6.5.4 (M.1371/A2-3.3.5.4) Continuous Operation Phase**

*The station shall remain in the continuous operation phase until it shuts down, enters assigned mode or is changing its report rate (refer Figure 13).*

**Figure 13****7.6.5.4.1 (M.1371/A2-3.3.5.4.1) Wait for NTS**

*The station shall now wait until this slot is approached.*

#### **7.6.5.4.2 (M.1371/A2-3.3.5.4.2) Decrement Slot Time-Out**

*Upon reaching the NTS, the SOTDMA time-out counter, for that slot, shall be decremented. This Slot Time-Out specifies how many frames the slot is allocated for. The Slot Time-Out shall always be included as part of the SOTDMA transmission.*

#### **7.6.5.4.3 (M.1371/A2-3.3.5.4.3) Slot Time-Out is zero**

*If the Slot Time-Out is zero, a new NTS shall be selected. The SI around the NS shall be searched for candidate slots and one of the candidates shall be randomly selected. The offset from the current NTS and the new NTS shall be calculated and assigned as a slot offset value. The new NTS shall be assigned a time-out value with a randomly selected value between TMO\_MIN and TMO\_MAX.*

*If the Slot Time-Out is more than zero, the slot offset value shall be set to zero.*

#### **7.6.5.4.4 (M.1371/A2-3.3.5.4.4) Assign Time-Out and offset to packet**

*The time-out and slot offset values shall be inserted into the SOTDMA Communication State (refer to 7.6.7.2.2).*

#### **7.6.5.4.5 (M.1371/A2-3.3.5.4.5) Transmit**

*A scheduled position report shall be inserted into the SOTDMA packet and transmitted in the allocated slot. The Slot Time-Out shall be decremented by one. The station shall then wait for the next NTS.*

#### **7.6.5.4.6 (M.1371/A2-3.3.5.5) Changing Report Rate**

*When the nominal Report Rate shall change then, the station shall enter change report rate phase (see Figure 14). During this phase, it shall reschedule its periodic transmissions to suit the new desired reporting rate.*

*The procedure, described in this section, shall be used for changes which will persist for at least 2 frames. For temporary changes, ITDMA transmissions shall be inserted between SOTDMA transmissions for the duration of the change.*

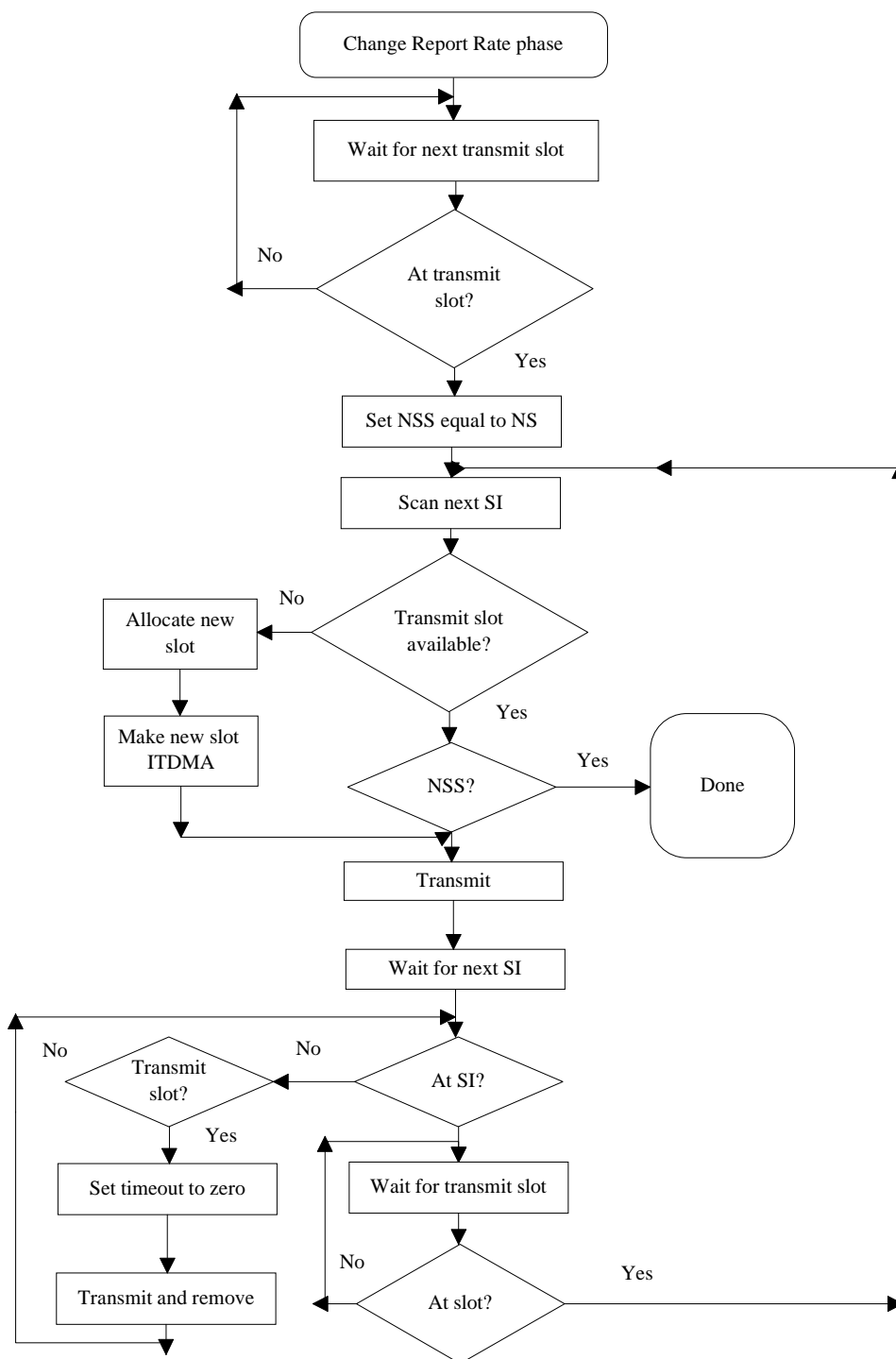


Figure 14

#### 7.6.5.4.7 (M.1371/A2-3.3.5.5.1) Wait for next Transmit Slot (TS)

Prior to changing its report rate, the station shall wait for the next slot, which has been allocated for own transmission. Upon reaching this slot, the associated NS shall be set to the new NSS. The slot, which was allocated for own transmission, shall be checked to make sure that the Slot Time-Out is non-zero. If it is zero, the Slot Time-Out shall be set to one.

#### 7.6.5.4.8 (M.1371/A2-3.3.5.5.2) Scan next SI

When using the new report rate, a new NI shall be derived. With the new NI, the station shall examine the area which is covered by the next SI. If a slot is found, which is allocated for own

*transmission, it shall be checked to see if it is associated with the NSS. If so, the phase is complete and the station returns to nominal operation. If not, the slot shall be kept with a time-out above zero.*

*If a slot was not found within the SI, a slot shall be allocated. The offset, in slots, between the current transmit slot and the new allocated slot, shall be calculated. The current transmit slot shall be converted into an ITDMA transmission which shall hold the offset with the keep flag set to TRUE.*

*The current slot shall then be used for transmission of periodic messages such as a position report.*

#### **7.6.5.4.9 (M.1371/A2-3.3.5.5.3) Wait for next SI**

*While waiting for the next SI, the station continuously scans the frame for slots which are allocated for own transmission. If a slot is found, the Slot Time-Out shall be set to zero. After transmission in that slot the slot shall be freed.*

*When the next SI is approached, the station shall begin to search for the transmit slot allocated within the SI. When found, the process shall be repeated again.*

#### **7.6.6 (M.1371/A2-3.3.6) Assigned operation**

*An autonomous station may be commanded to operate according to a specific transmission schedule, defined by a competent authority via a base or repeater station using Message 16, the "Assigned Mode Command". When operating in the Assigned Mode, the station shall use Message 2, the "Position Report," for its transmission of all of its position reports instead of Message 1. The Assigned Mode shall effect only the station's transmission of position reports, and no other behaviour of the station shall be affected. The transmission of position reports shall be only as directed by Message 16, and the station shall not change its reporting rate for changing course and speed. Assignments shall be limited in time and will be re-issued by the competent authority as needed. Two levels of assignments shall be possible:*

##### **7.6.6.1 (M.1371/A2-3.3.6.1) Assignment of Reporting Rate (Rr)**

*When assigned a new reporting rate, the mobile station shall continue to autonomously schedule its transmissions using the assigned Reporting Rate as instructed by a competent authority. The process of changing reporting rate is the same as described 7.6.5.4.6. Reporting rates.*

##### **7.6.6.1.1 (M.1371/A2-3.3.6.2) Assignment of transmission slots**

*A station may be assigned the exact slots to be used for repeatable transmissions by a competent authority using the "Assigned Mode Command" Message 16 (refer to 7.7.6).*

##### **7.6.6.1.2 (M.1371/A2-3.3.6.2.1) Entering assigned mode**

*Upon receipt of the "Assigned Mode Command" Message 16,, the station shall allocate the specified slots and begin transmission in these. It shall continue to transmit in the autonomously allocated slots with a zero Slot Time-Out and a zero slot offset, until those slots have been removed from the transmission schedule. A transmission with a zero Slot Time-Out and a zero slot offset indicates that this is the last transmission in that slot with no further allocation in that SI.*

##### **7.6.6.1.3 (M.1371/A2-3.3.6.2.2) Operating in the assigned mode**

*The assigned slots shall use the SOTDMA access scheme, with the timeout value set to the assigned Slot Time-Out. The assigned Slot Time-Out shall be between 3 and 8 frames. For each frame, the Slot Time-Out shall be decremented.*

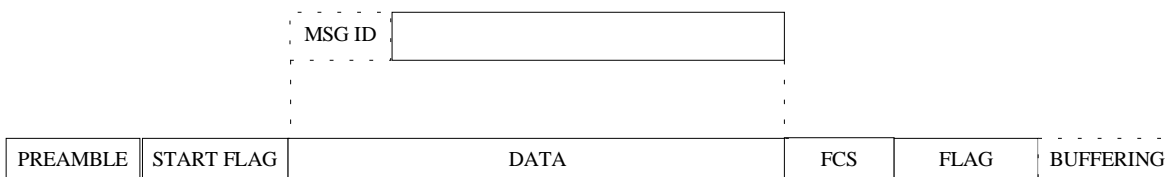
##### **7.6.6.1.4 (M.1371/A2-3.3.6.2.3) Returning to autonomous and continuous mode**

*Unless a new assignment is received, the assignment shall be terminated, when the Slot Time-Out reaches zero of any assigned slot. At this stage, the station shall return to autonomous and continuous mode.*

The station shall initiate the return to autonomous and continuous mode as soon as it detects an assigned slot with a zero Slot Time-Out. This slot shall be used to re-enter the network. The station shall randomly select an available slot from candidate slots within a NI of the current slot and make this the NSS. It shall then substitute the assigned slot for an ITDMA slot and shall use this to transmit the relative offset to the new NSS. From this point on, the process shall be identical to the network entry phase (see 7.6.5.2).

#### 7.6.7 (M.1371/A2-3.3.7) Message structure

Messages, which are part of the access schemes, shall have the following structure shown in Figure 15 inside the data portion of a data packet:



**Figure 15**

Each message is described using a table with parameter fields listed from top to bottom. Each parameter field is defined with the most significant bit first.

Parameter fields containing sub-fields (e. g. Communication State) are defined in separate tables with sub-fields listed top to bottom most significant bit first within each sub-field.

Character strings are presented left to right most significant bit first. All unused characters shall be represented by the @-symbol, and they shall be placed at the end of the string.

When data is output on the VHF data link it shall be grouped in bytes of 8 bits from top to bottom of the table associated with each message in accordance with ISO/IEC 3309: 1993. Each byte shall be output with least significant bit first. During the output process, data shall be subject to bit-stuffing and NRZI coding as described in 7.5.2.

Unused bits in the last byte shall be set to zero in order to preserve byte boundary.

Generic Example for a message table:**Table 15**

<i>Parameter</i>	<i>Sym</i>	<i>No of bits</i>	<i>Description</i>
<i>P1</i>	<i>T</i>	6	<i>Parameter 1</i>
<i>P2</i>	<i>D</i>	1	<i>Parameter 2</i>
<i>P3</i>	<i>I</i>	1	<i>Parameter 3</i>
<i>P4</i>	<i>M</i>	27	<i>Parameter 4</i>
<i>P5</i>	<i>N</i>	2	<i>Parameter 5</i>
<i>Unused</i>	<i>0</i>	3	<i>Unused bits</i>

Logical view of data as described in 7.6.7:

**Table 16**

<i>Bit Order</i>	M---L--	M-----	-----	-----	--LML000
<i>Symbol</i>	TTTTTDTI	MMMMMMMM	MMMMMMMM	MMMMMMMM	MMMN000
<i>Byte Order</i>	1	2	3	4	5

Output order to VHF data link (bit-stuffing is disregarded in the example):

**Table 17**

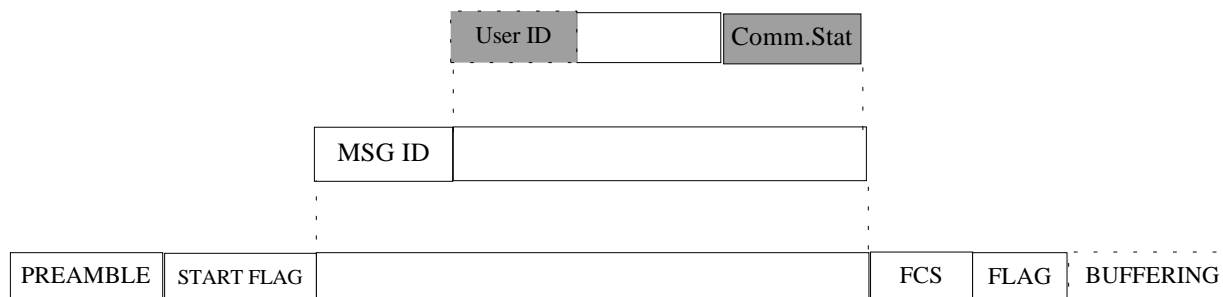
<i>Bit Order</i>	--L---M	-----M	-----	-----	000LML--
<i>Symbol</i>	IDTTTTT	MMMMMMMM	MMMMMMMM	MMMMMMMM	000NNMMM
<i>Byte Order</i>	1	2	3	4	5

**7.6.7.1 (M.1371/A2-3.3.7.1) Message ID (MSG ID)**

The message ID shall be 6 bits long and shall range between 0 and 63. The message ID shall identify message type.

**7.6.7.2 (M.1371/A2-3.3.7.2) SOTDMA message structure**

The SOTDMA message structure shall supply the necessary information in order to operate in accordance with 7.6.4.4. The message structure is shown in Figure 16;

**Figure 16**

#### 7.6.7.2.1 (M.1371/A2-3.3.7.2.1) SOTDMA User ID

The User ID shall be the MMSI. The MMSI is 30 bits long. The first 9 digits (most significant digits) shall be used only. Recommendation ITU-R M. 1083 shall not be applied with respect to the 10<sup>th</sup> digit (least significant digit).

#### 7.6.7.2.2 (M.1371/A2-3.3.7.2.2) SOTDMA communication state

The Communication State provides the following functions:

- 1) It contains information used by the slot allocation algorithm in the SOTDMA concept.
- 2) It also indicates the synchronisation state. The SOTDMA Communication State is structured as shown in Table 18:

**Table 18**

Parameter	No of Bits	Description
Sync State	2	0 UTC Direct (refer to 7.4.1.1) 1 UTC Indirect (refer to 7.4.1.2) 2 Station is synchronised to a Base Station (refer to 7.4.1.3) 3 Station is synchronised to an other station based on the highest number of received stations (refer to 7.4.1.4)
Slot Time-Out	2	Specifies frames remaining until a new slot is selected 0 means that this was the last transmission in this slot 1-2 means that 1 or 2 frames respectively are left until slot change 3 means that 3 or more frames are left until slot change
Sub Message	14	The sub message depends on the current value in slot time out as described in the Table 19

The SOTDMA Communication State shall apply only to the slot in the channel where the relevant transmission occurs.

#### 7.6.7.2.3 (M.1371/A2-3.3.7.2.3) Sub Messages

**Table 19**

Slot Time-Out	Sub Message	Description
3	Received stations	Number of stations which the station currently is receiving (between 0 and 16383)
2	Slot number	Slot number used for this transmission (between 0 and 2249)
1	UTC hour and minute	If the station has access to UTC, the hour and minute shall be indicated in this sub message. Hour (0-23) shall be coded in bits 13 to 9 of the sub message (bit 13 is MSB). Minute (0-59) shall be coded in bits 8 to 2.
0	Slot offset	If the Slot Time-Out value is 0 (zero) then the slot offset shall indicate the relative jump to the slot in which transmission will occur during next frame. ( $\pm 2,047$ means offset information is not given). If the slot offset is zero, the slot shall be de-allocated after transmission.

#### 7.6.7.3 (M.1371/A2-3.3.7.3) ITDMA message structure

The ITDMA message structure supplies the necessary information in order to operate in accordance with 7.6.4.1. The message structure is shown in Figure 17:

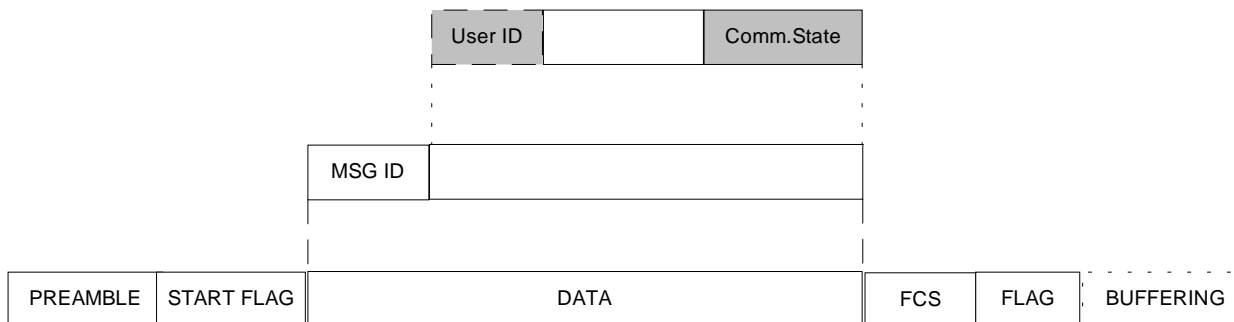


Figure 17

#### 7.6.7.3.1 (M.1371/A2-3.3.7.3.1) ITDMA User ID

The user ID shall be the MMSI. The MMSI is 30 bits long. The first 9 digits (most significant digits) shall be used only. Recommendation ITU-R M. 1083 shall not be applied with respect to the 10<sup>th</sup> digit (least significant digit).

#### 7.6.7.3.2 (M.1371/A2-3.3.7.3.2) ITDMA communication state

The Communication State provides the following functions:

- 1) It contains information used by the slot allocation algorithm in the ITDMA concept;
- 2) It also indicates the synchronisation state.

The ITDMA Communication State shall be structured as shown in Table 12:

Table 20

Parameter	No of Bits	Description
Sync State	2	0 UTC Direct (refer to 0) 1 UTC Indirect (refer to 7.4.1.2) 2 Station is synchronised to a Base Station (refer to 7.4.1.3) 3 Station is synchronised to another station based on the highest number of received stations (refer to 7.4.1.4).
Slot Allocation	13	Offset to next slot to be used, or zero (0) if no more transmissions.
Number of Slots	2	Number of consecutive slots to allocate. (0 = 1 slot, 1 = 2 slots, 2 = 3 slots, 3 = 4 or 5 slots).
Keep flag	1	Set to TRUE (= 1) if the slot shall remain allocated for one additional frame.

The ITDMA Communication State shall apply only to the slot in the channel where the relevant transmission occurs.

#### 7.6.7.4 (M.1371/A2-3.3.7.4) RATDMA message structure

The RATDMA access scheme may use message structures determined by message ID and may thus lack a uniform structure.

A message with a Communication State may be transmitted using RATDMA in the following situations

- 1) When initially entering the network (refer to 7.6.4.1.1)
- 2) When repeating a message

The Communication State when initially entering the network shall be set in accordance with 7.6.4.1.1 and 7.6.7.3.2.

*The Communication State when repeating a message shall be set in accordance with 7.7.7.*

#### **7.6.7.5 (M.1371/A2-3.3.7.5) FATDMA message structure**

*The FATDMA access scheme may use message structures determined by message ID and may thus lack a uniform structure.*

*A message with a Communication State may be transmitted using FATDMA, e. g. when repeated. In this situation, the Communication State shall be set in accordance with 7.7.7.*

#### **7.6.8 (M.1371/A2-3.3.8) Message summary**

*This paragraph describes all messages on the TDMA data link. The message table (Table 22) uses the following columns:*

**Table 21**

<i>Message ID</i>	<i>Message identifier as defined in 7.6.7.1</i>
<i>Name</i>	<i>Name of the message.</i>
<i>Description</i>	<i>Brief description of the message. See 0 etc. for detailed description of each message</i>
<i>Category</i>	<i>Specifies, if the message has been included in order to fulfil a functional requirement as specified by the operational use of the AIS, or if the message is included for system management purposes.</i> F = Functional Message S = System Management Message F/S = Functional and System Management Message
<i>Priority</i>	<i>Priority as defined in 7.7.2.3</i>
<i>Operational Mode</i>	<i>A station transmitting a specific message will also say something about its mode of operation as defined in 7.6.2. A combination of modes indicates that the station can be in either of these.</i> AU = Autonomous AS = Assigned IN = Interrogation / Polled Mode
<i>Access Scheme</i>	<i>This column indicates how a station may select slots for transmission of this message. The access scheme used for the selection of slots does not determine the message type nor the Communication State of the message transmissions in those slots.</i>
<i>Communication State</i>	<i>Specifies which Communication State is used in the message. If a message does not contain a Communication State, it is stated as "N/A". Communication State, where applicable, indicates an expected future use of that slots. Where no Communication State is indicated the slots are immediately available for future use.</i>

The defined messages are summarised in the Table 22 below:

**Table 22**

<b>Msg. ID</b>	<b>Name</b>	<b>Description</b>	<b>Cat ego ry</b>	<b>Prio rity</b>	<b>Operati on mode</b>	<b>Access Schemes</b>	<b>Communi cation State</b>
1.	Position Report	Scheduled position report	F/S	1	AU	SOTDMA, RATDMA,	SOTDMA

						ITDMA (1)	
2	Position Report	Assigned Scheduled position report	F/S	1	AS	SOTDMA	SOTDMA
3.	Position Report	Special position report, response to interrogation	F/S	1	AU	RATDMA	ITDMA
4.	Base Station Report	Position, UTC, Date and current slot number of base station	F/S	1	AS (3)	FATDMA	SOTDMA
5.	Static and Voyage Related Data	Scheduled static vessel data report / Aids-to-Navigation data	F	4 (5)	AU, AS	RATDMA, ITDMA (2)	N/A
6.	Binary Addressed Message	Binary data for addressed communication	F	4	AU, AS, IN	RATDMA, ITDMA (2)	N/A
7.	Binary Acknowledgement	Acknowledgement of received addressed binary data	S	1	AU, AS, IN	RATDMA, ITDMA (2)	N/A
8.	Binary broadcast Message	Binary data for broadcast communication	F	4	AU, AS, IN	RATDMA, ITDMA (2)	N/A
9.	Special Position Report	Position Report for stations other than ship stations only	F/S	1	AU, AS	SOTDMA, RATDMA, ITDMA (1)	SOTDMA,
10.	UTC/Date inquiry	Request UTC and date	F/S	3	AU, AS, IN	RATDMA, ITDMA (2)	N/A
11.	UTC/Date Response	Current UTC and date if available	F/S	3	AU, AS, IN	RATDMA, ITDMA (2)	SOTDMA
12.	Addressed Safety Related Message	Safety related data for addressed communication	F	2	AU, AS, IN	RATDMA, ITDMA (2)	N/A
13.	Safety Related Acknowledgement	Acknowledgement of received addressed safety related message	S	1	AU, AS, IN	RATDMA, ITDMA (2)	N/A
14.	Safety Related broadcast Message	Safety related data for broadcast communication	F	2	AU, AS, IN	RATDMA, ITDMA (2)	N/A
15.	Interrogation	Request for a specific message type (can result in multiple responses from one or several stations) (4)	F	3	AU, AS, IN	RATDMA, ITDMA (2)	N/A
16.	Assigned Mode Command	Assignment of a specific report behaviour by competent authority using a base station	F/S	1	AS (3)	RATDMA, ITDMA (2)	N/A
17.	DGNSS Broadcast Binary Message	DGNSS corrections provided by a base station	F	2	AS (3)	FATDMA, ITDMA, RATDMA	N/A
18	not used	not used	-	-	-	-	-
19.	VTS Targets	VTS derived target	F	2	AS (3)	FATDMA, ITDMA, RATDMA	N/A
20.	Data Link Management Message	Reserve slots for base station(s).	S	1	AS(3)	FATDMA	N/A
21.	Test/Evaluation Message	Reserved for Proprietary and/or local use.	F	4	AU, AS, IN	FATDMA, ITDMA, RATDMA	N/A
22.	Channel Management	Management of channels and transceiver modes by a base station.	S	1	AS (3)	FATDMA, ITDMA, RATDMA	N/A

N/A Not Applicable

ACK Acknowledgement

VTS Vessel Traffic Services

Notes:

1) ITDMA is used during the first frame phase (see 7.6.5.3) and during a turn. SOTDMA is used during the continuous operation phase (see 7.6.5.4). RATDMA can be used at any time to transmit additional position reports.

2) RATDMA or ITDMA in a SOTDMA, or in the case of a base station an FATDMA allocated slot can be used in order to allocate a slot for transmission of this message type.

3) A base station is always operating in assigned mode using a fixed transmission schedule for its periodic transmissions.

4) For interrogation of UTC and date, message identifier 10 shall be used.

5) Priority 3, if in response to interrogation.

### 7.6.9 (M.1371/A2-3.3.8.2) Message field definitions

[The message parameter fields are joined to messages without using delimiters.]

Unless otherwise specified all fields are binary. All numbers expressed are in decimal notation. Negative numbers are expressed using 2's complement.

*All positions shall be transmitted in WGS 84 datum.*

*Some telegrams specify the inclusion of character data, such as ship's name, destination, call sign, and more. These fields shall use a 6-bit ASCII as defined in the table below:*

**Table 23**

6-Bit ASCII				STANDARD ASCII			6-Bit ASCII				STANDARD ASCII		
Chr	Dec	Hex	Binary	Dec	Hex	Binary	Chr	Dec	Hex	Binary	Dec	Hex	Binary
@	0	0x00	00 0000	64	0x40	0100 0000	!	33	0x21	10 0001	33	0x21	0010 0001
A	1	0x01	00 0001	65	0x41	0100 0001	"	34	0x22	10 0010	34	0x22	0010 0010
B	2	0x02	00 0010	66	0x42	0100 0010	#	35	0x23	10 0011	35	0x23	0010 0011
C	3	0x03	00 0011	67	0x43	0100 0011	\$	36	0x24	10 0100	36	0x24	0010 0100
D	4	0x04	00 0100	68	0x44	0100 0100	%	37	0x25	10 0101	37	0x25	0010 0101
E	5	0x05	00 0101	69	0x45	0100 0101	&	38	0x26	10 0110	38	0x26	0010 0110
F	6	0x06	00 0110	70	0x46	0100 0110	`	39	0x27	10 0111	39	0x27	0010 0111
G	7	0x07	00 0111	71	0x47	0100 0111	(	40	0x28	10 1000	40	0x28	0010 1000
H	8	0x08	00 1000	72	0x48	0100 1000	)	41	0x29	10 1001	41	0x29	0010 1001
I	9	0x09	00 1001	73	0x49	0100 1001	*	42	0x2A	10 1010	42	0x2A	0010 1010
J	10	0x0A	00 1010	74	0x4A	0100 1010	+	43	0x2B	10 1011	43	0x2B	0010 1011
K	11	0x0B	00 1011	75	0x4B	0100 1011	,	44	0x2C	10 1100	44	0x2C	0010 1100
L	12	0x0C	00 1100	76	0x4C	0100 1100	-	45	0x2D	10 1101	45	0x2D	0010 1101
M	13	0x0D	00 1101	77	0x4D	0100 1101	.	46	0x2E	10 1110	46	0x2E	0010 1110
N	14	0x0E	00 1110	78	0x4E	0100 1110	/	47	0x2F	10 1111	47	0x2F	0010 1111
O	15	0x0F	00 1111	79	0x4F	0100 1111	0	48	0x30	11 0000	48	0x30	0011 0000
P	16	0x10	01 0000	80	0x50	0101 0000	1	49	0x31	11 0001	49	0x31	0011 0001
Q	17	0x11	01 0001	81	0x51	0101 0001	2	50	0x32	11 0010	50	0x32	0011 0010
R	18	0x12	01 0010	82	0x52	0101 0010	3	51	0x33	11 0011	51	0x33	0011 0011
S	19	0x13	01 0011	83	0x53	0101 0011	4	52	0x34	11 0100	52	0x34	0011 0100
T	20	0x14	01 0100	84	0x54	0101 0100	5	53	0x35	11 0101	53	0x35	0011 0101
U	21	0x15	01 0101	85	0x55	0101 0101	6	54	0x36	11 0110	54	0x36	0011 0110
V	22	0x16	01 0110	86	0x56	0101 0110	7	55	0x37	11 0111	55	0x37	0011 0111
W	23	0x17	01 0111	87	0x57	0101 0111	8	56	0x38	11 1000	56	0x38	0011 1000
X	24	0x18	01 1000	88	0x58	0101 1000	9	57	0x39	11 1001	57	0x39	0011 1001
Y	25	0x19	01 1001	89	0x59	0101 1001	:	58	0x3A	11 1010	58	0x3A	0011 1010
Z	26	0x1A	01 1010	90	0x5A	0101 1010	;	59	0x3B	11 1011	59	0x3B	0011 1011
[	27	0x1B	01 1011	91	0x5B	0101 1011	<	60	0x3C	11 1100	60	0x3C	0011 1100
\	28	0x1C	01 1100	92	0x5C	0101 1100	=	61	0x3D	11 1101	61	0x3D	0011 1101
]	29	0x1D	01 1101	93	0x5D	0101 1101	>	62	0x3E	11 1110	62	0x3E	0011 1110

^	30	0x1E	01 1110	94	0x5E	0101 1110	?	63	0x3F	11 1111	63	0x3F	0011 1111
_	31	0x1F	01 1111	95	0x5F	0101 1111							
Sp ace	32	0x20	10 0000	32	0x20	0010 0000							

### 7.6.10 (M.1371/A2-3.3.8.2.1) Message 1, 2, 3: Position Reports

The position report shall be output periodically by mobile stations.

**Table 24**

Parameter	No of Bits	Description
Message ID	6	Identifier for this message 1, 2 or 3.
DTE	1	Data Terminal Ready (0 = Available; 1 = Not Available = default).
DI Data Indicator	1	Indicates data available to transmit (0 = Not Available = default; 1 = Available)
User ID	30	MMSI number.
Navigational Status	4	0 = Under Way using engine = Default, 1= At Anchor, 2 = Not Under Command, 3 = Restricted Manoeuvrability, 4 = Constrained by her draught; 5= Moored; 6 = Aground; 7 = Engaged in Fishing; 8 = Under way sailing; 9 = reserved for future amendment of Navigational Status for HSC; 10 = reserved for future amendment of Navigational Status for WIG;  11 - 15 = reserved for future use.
Rate of Turn $ROT_{AIS}$	8	$\pm 127$ . (-128 (80 hex) indicates not available, which shall be the default). Coded by $ROT_{AIS}=4.733 \text{ SQRT}(ROT_{IND})$ degrees/min  $ROT_{IND}$ is the Rate of Turn ( 720 degrees per minute), as indicated by an external sensor.  + 127 = turning right at 720 degrees per minute or higher; - 127 = turning left at 720 degrees per minute or higher
SOG	10	Speed Over Ground in 1/10 knot steps (0-102.4 knots) . 1023 = not available, 1022 = 102.2 knots or higher.
Position Accuracy	1	1 = High (< 10m; Differential Mode of e.g. DGNSS receiver) 0 = low (> 10m; Autonomous Mode of e.g. GNSS receiver or of other Electronic Position Fixing Device); Default = 0
Longitude	28	Longitude in 1/10 000 minute ( $\pm 180$ degrees, East = positive, West = negative. 181 degrees (6791AC0 hex) = not available = default)
Latitude	27	Latitude in 1/10 000 minute ( $\pm 90$ degrees, North = positive, South = negative. 91 degrees (3412140 hex) = not available = default)
COG	12	Course Over Ground in 1/10 degree (0-3599). 3600 (E10 hex)= not available = default; 3601 - 4095 shall not be used
True Heading	9	Degrees (0-359) (511 indicates not available = default).
Time stamp	6	UTC second when the report was generated (0-59, or 60 if time stamp is not available, which shall also be the default value, or 61 if positioning system is in manual input mode or 62 if Electronic Position Fixing System operates in estimated (dead reckoning) mode, or 63 if the positioning system is inoperative,).
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. Shipborne transponders shall use the default value 0 (not repeated); refer to 7.7.7 ; 0...3; 0 = default; 3 = do not repeat.
Reserved for regional applications	4	Reserved for definition by a competent regional authority. Shall be set to zero, if not used for any regional application. Regional applications shall not use zero.
Spare	1	Not used. Shall be set to zero.
Comm State	18	See Table 25 below.
Total no of bits	168	

**Table 25**

<b>Message ID</b>	<b>Comm State (see 7.6.7.2.2)</b>
1	SOTDMA Communication State
2	SOTDMA Communication State
3	ITDMA Communication State

### 7.6.10.1 DTE and DI indicators

*The DTE and DI indicators promote efficient use of the data link by reducing unnecessary transmissions of data and promoting throughput.*

#### 7.6.10.1.1 The DTE indicator

*The DTE indicator is an abbreviation for Data Terminal Equipment indicator. The purpose of the DTE indicator is to indicate to an application on the receiving side that, if set to "available", the transmitting station conforms at least to the minimum keyboard and display requirements. On the transmitting side the DTE indicator may also be set by an external application via the Presentation Interface. On the receiving side the DTE indicator is only used as information provided to the application layer, that the transmitting station is available for communications.*

#### 7.6.10.1.2 The DI indicator

*The DI indicator is an abbreviation for Data Indicator. This indicator is provided for VDL monitoring purposes. This indicator shall be set by the transmitting station any time that a safety related or binary message is queued for transmission on the VDL.*

### 7.6.11 (M.1371/A2-3.3.8.2.2) Message 4: Base Station Report

Message 4 is identical to Message 11: UTC and Date Response

*They shall be used for reporting UTC time and date, and, at the same time, position. A base station shall use Message 4 in its periodical transmissions. A mobile station shall only output Message 11 in response to interrogation by Message 10.*

**Table 26**

<b>Parameter</b>	<b>No of Bits</b>	<b>Description</b>
Message ID	6	Identifier for this message 4, 11; 4 = UTC and position report from base station; 11 = UTC and position response from mobile station.
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. Shipborne transponders shall use the default value 0 (not repeated); refer to 7.7.7; 0...3; 0 = default; 3 = do not repeat.
User ID	30	MMSI number.
UTC Year	14	1 - 9999. 0 = UTC year not available = default.
UTC Month	4	1 - 12 ; 0 = UTC month not available = default; 13 - 15 not used
UTC Day	5	1 - 31 ; 0 = UTC day not available = default.
UTC Hour	5	0 - 23 ; 24 = UTC hour not available = default; 25 - 31 not used
UTC Minute	6	0 - 59 ; 60 = UTC minute not available = default; 61 - 63 not used
UTC Second	6	0 - 59 ; 60 = UTC second not available = default; 61 - 63 not used.
Position Accuracy	1	1 = High (< 10m; Differential Mode of e.g. DGNS receive) 0 = low (> 10m; Autonomous Mode of e.g. GNSS receiver, or of other Electronic Position Fixing Device), Default = 0
Longitude	28	Longitude in 1/10 000 minute ( $\pm$ 180 degrees, East = positive, West =

		<i>negative</i> ); 181 degrees (6791AC0 hex) = not available = default
Latitude	27	Latitude in 1/10 000 minute ( $\pm 90$ degrees, North = positive, South = negative); 91 degrees (3412140 hex) = not available = default
Type of Electronic Position Fixing Device	4	use of differential corrections is defined by field 'position accuracy' above; 0 = Undefined (default); 1 = GPS, 2 = GLONASS, 3 = Combined GPS/GLONASS, 4 = Loran-C, 5 = Chayka, 6 = Integrated Navigation System, 7 = surveyed (message 4: base station) 8 - 15 = not used;
Spare	12	Not used. Shall be set to zero.
Communication State	18	SOTDMA Communication State as described in 7.6.7.2.2
Total no of bits	168	

### 7.6.12 (M1371/A2-3.3.8.2.3) Message 5: Ship Static and Voyage related data

This message is used to transmit station data that is not dynamic. It has 4 different data subsets defined by a Data Set Indicator as given by Table 27.

**Table 27**

Parameter	Number of bits		Description
Message ID	6		Identifier for this message 5
Repeat Indicator	2		Used by the repeater to indicate how many times a message has been repeated. Shipborne transponders shall use the default value 0 (not repeated); refer to 7.7.7 ; 0...3; 0 = default; 3 = do not repeat.
User ID	30		MMSI number
Data Set Indicator (DSI)	2		Indicates the Data Set, which shall follow this flag to complete the message: 0 = Ship Static and Voyage Related Data, as defined in §3.3.8.2.3.1. This data set shall only be transmitted by a mobile station. 1 = Extended Ship Static and Voyage Related Data as defined in §3.3.8.2.3.2. This data set shall only be transmitted by a mobile station. 2 = Aids-to-Navigation Data, as defined in §3.3.8.2.3.3. This data set shall only be transmitted by a mobile or a base or a repeater station which is mounted on an Aids-to-Navigation. 3 = Regional Ship Static and Voyage Related Data, as defined in §3.3.8.2.3.4. This data set shall only be used by a mobile station, not operating in international waters. AIS stations designed for operation in international waters are not required to decode the Regional Ship Static and Voyage Related data set.
Data Set	DSI	Bits	Data Set as selected by Data Set Indicator (refer to §3.3.8.2.3.1 - §3.3.8.2.3.4); Length of Data Set portion depends on Data Set selected by DSI
	0	384	
	1	144 – 616	
	2	232	
	3	Max 384	
Total Number of Bits	DSI	Bits	Total length of messages depending on Data Set selected by DSI  <u>DSI      Number of Slots occupied:</u> 0      2 slots 1      2 to 3 slots 2      2 slots 3      2 slots
	0	424	
	1	184 – 654	
	2	272	

3	Max 424
---	---------

### 7.6.12.1 (M.1371/A2-3.3.8.2.3.1) Data Set for Standard Ship Static and Voyage Related Data

If the Data Set Indicator in Message 5 is set to zero (0) the Standard Ship Static and Voyage Related data set shall be used to complete Message 5 as defined in Table 18 below.

**Table 28**

Parameter	Number of bits	Description
IMO number	30	1 - 999999999 ; 0 = not available = default
Call sign	42	7 × 6 bit ASCII characters, "@@@@@@@@" = not available = default.
Name	120	Maximum 20 characters 6 bit ASCII, "@@" = not available = default.
Type of ship and cargo type	8	0 = not available or no ship = default; see table 18.1 1 - 99 = as defined in § 3.3.8.2.3.5; 100 - 199 = preserved, for regional use; 200 - 255 = preserved, for future use.
Reference for Position	30	Reference point for reported position; Also indicates the dimension of ship in metres (see Fig. 15 )
Type of Electronic Position Fixing Device	4	0 = Undefined (default); 1 = GPS, 2 = GLONASS, 3 = Combined GPS/GLONASS, 4 = Loran-C, 5 = Chayka, 6 = Integrated Navigation System, 7 = surveyed 8 - 15 = not used;
ETA	20	Estimated Time of Arrival; MMDDHHMM
		Bits 19 - 16: month; 1 - 12; 0 = not available = default;
		Bits 15 - 11: day; 1 - 31; 0 = not available = default;
		Bits 10 - 6: hour; 0 - 23; 24 = not available = default;
		Bits 5 - 0: minute; 0 - 59; 60 = not available = default
Maximum Present Static Draught	8	in 1/10 m, 255 = draught 25.5 m or greater, 0 = not available = default; in accordance with IMO Resolution A.851
Destination	120	Maximum 20 characters using 6-bit ASCII; "@@" = not available.
Spare	2	Spare. Not used. Shall be set to zero.
Number of bits	384	

Table 29

Identifiers to be used by ships to report their type			
Identifier No.	Special craft		
50	Pilot vessel		
51	Search and rescue vessels		
52	Tugs		
53	Port tenders		
54	Vessels with anti-pollution facilities or equipment		
55	Law enforcement vessels		
56	Spare – for assignments to local vessels		
57	Spare – for assignments to local vessels		
58	Medical transports (as defined in the 1949 Geneva Conventions and Additional Protocols)		
59	Ships according to Resolution No 18 (Mob-83)		
Other ships			
First digit (*)	Second digit (*)	First digit (*)	Second digit (*)
1 - reserved for future use	0 – All ships of this type	-	0 – Fishing
2 – WIG	1 – Carrying DG, HS, or MP IMO hazard or pollutant category A	-	1 - Towing
3 - see right column	2 – Carrying DG, HS, or MP IMO hazard or pollutant category B	3 - Vessel	2 - Towing and length of the tow exceeds 200 m or breadth exceeds 25 m
4 – HSC	3 – Carrying DG, HS, or MP IMO hazard or pollutant category C	-	3 - Engaged in dredging or underwater operations
5 – see above	4 – Carrying DG, HS, or MP IMO hazard or pollutant category D	-	4 - Engaged in diving operations
	5 – reserved for future use	-	5 - Engaged in military operations
6 – Passenger ships	6 – reserved for future use	-	6 - Sailing
7 – Cargo ships	7 –reserved for future use	-	7 - reserved for future use
8 – Tanker(s)	8 – reserved for future use	-	8 - reserved for future use
9 – Other types of ship	9 – No additional information	-	9 - reserved for future use

DG: Dangerous Goods

HS: Harmful Substances

MP: Marine Pollutants

(\*) NOTE – The identifier shall be constructed by selecting the appropriate first and second digits.

### Reference Point for reported position and Dimensions of Ship:

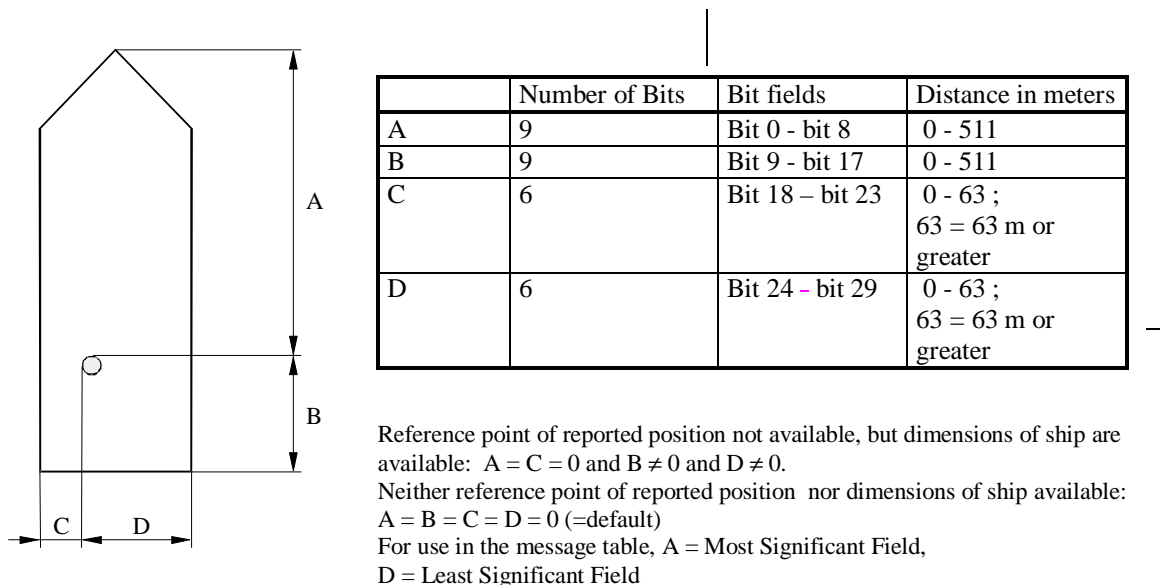


Figure 18

#### 7.6.12.2 (M.1371/A2-3.3.8.2.3.2) Data Set for Extended Ship Static and Voyage Related Data

If the Data Set Indicator in Message 5 is set to one (1) the Extended Ship Static and Voyage Related data set shall be used to complete Message 5 as defined in Table 18.2.

All data in the Extended Ship Static and Voyage Related Data Set shall only be input at master's discretion, and shall only be available from a ship by interrogation by competent authority by Interrogation Message 15.

When transmitting Route Plan the transmitting station shall include up to 12 Next Waypoints, if available, and / or a route specified by a textual description, if available.

If a station includes waypoints to describe the Route Plan, than waypoints which already have been passed during this voyage shall not be included.

The Next Waypoints shall be transmitted in the order of the intended passage.

Table 30

Parameter	Number of bits	Description
NWP	4	Number of Next Waypoints available (1 -11); 0 = no Next Waypoint available = default; 12 - 15 = not used
WP <i>i</i> .Lon	22	Longitude of Next Waypoint <i>i</i> in 1/100 min ( $\pm 180$ degrees, East = positive, West = negative). Field required if and as often as $1 \leq i \leq NWP$ , $i = 1, 2, 3, \dots, 12$ ; field not required if NWP = 0.
WP <i>i</i> .Lat	21	Latitude of Next Waypoint <i>i</i> in 1/100 min ( $\pm 90$ degrees, North = positive, South = negative). Field required if and as often as $1 \leq i \leq NWP$ , $i = 1, 2, 3, \dots, 12$ ; field not required if NWP = 0.
Route specified by Textual Description	120	Description of the route information in textual form instead of waypoints, e. g. "West Channel"; maximum 20 characters using 6-bit ASCII; "#####" = not available.
Number of	13	Current number of persons on-board, including crew members: 0 – 8191

Persons		default = 0 = not available
Spare	0 to 7 Bits depending on NWP	Spare. Not used. Shall be set to zero NWP:            0 1 2 3 4 5 6 7 8 9 10 11 Spare bits:    7 4 1 6 3 0 5 2 7 4 1 6
Number of bits	144 – 616	The number of bits may be calculated as follows: 137 + NWP * 43 + Spare

The number of slots used for this message depends on the number of Next Waypoints transmitted as follows:

**Table 31**

<b>Number of Next Waypoints transmitted</b>	0	1	2	3	4	5	6	7	8	9	10	11
<b>Number of slots used for this message</b>	2	2	2	2	2	2	3	3	3	3	3	3

### 7.6.12.3 (M.1371/A2-3.3.8.2.3.3) Data Set for Aids-to-Navigation Data

If the Data Set Indicator in Message 5 is set to two (2) the Aids-to-Navigation data set shall be used to complete Message 5 as defined in Table .

This message shall only be transmitted by stations which are installed on an Aids-to-Navigation and operated by a competent authority.

Stations which transmit Message 5 with an Aids-to-Navigation data set shall transmit this message autonomously at a Reporting Rate of once per three (3) minutes. If the station is a mobile station mounted on an Aids-to-Navigation, its Reporting Rate may overridingly be set by an Assigned Mode Command (Message 16) via the VHF data link, or by an external command. Mobile stations which are mounted on an Aids-to-Navigation and transmit Message 5 with an Aids-to-Navigation data set shall not transmit Position Reports (Messages 1, 2, or 3). A base or a repeater station which is mounted on an Aids-to-Navigation and which transmits Message 5 with an Aids-to-Navigation data set shall also transmit Base Station Report (Message 4).

Stations which transmit Message 5 with an Aids-to-Navigation data set shall also transmit this message upon interrogation by Interrogation Message 15.

**Table 32**

Parameter	Number of bits	Description
Type of Aids-to- Navigation	5	0 = not available = default; 1 - 15 = Fixed Aids; 16 - 31 = Floating Aids; refer to Table 18.4
Name of Aids-to- Navigation	120	Maximum 20 characters 6 bit ASCII, "#####" = not available = default.
Position accuracy	1	1 = high (< 10 m; Differential Mode of e.g. DGNSS receiver) 0 = low (> 10 m; Autonomous Mode of e. g. GNSS receiver or of other Electronic Position Fixing Device) ; Default = 0
Longitude	28	Longitude in 1/10 000 min of position of Aids-to-Navigation (±180 degrees, East = positive, West = negative. 181 degrees (6791AC0 hex) = not available = default)
Latitude	27	Latitude in 1/10 000 min of Aids-to-Navigation (±90 degrees, North = positive, South = negative, 91 degrees (3412140 hex) = not available = default)
Reference for Position	30	Reference point for reported position; Also indicates the dimension of Aids-to-Navigation in metres (see Fig. 15 and § 3.3.8.2.3.6)
Type of Electronic Position Fixing Device	4	0 = Undefined (default); 1 = GPS, 2 = GLONASS, 3 = Combined GPS/GLONASS, 4 = Loran-C, 5 = Chayka, 6 = Integrated Navigation System, 7 = surveyed

		8 - 15 = not used;
Time Stamp	6	UTC second when the report was generated (0 –59, or 60 if time stamp is not available, which shall also be the default value, or 61 if positioning system is in manual input mode, or 62 if Electronic Position Fixing System operates in estimated (dead reckoning) mode, or 63 if the positioning system is inoperative)
Status of Aids-to- Navigation	3	Status of Lights: 0 = no Lights mounted; 1= Lights mounted, but status not available = default; 2= Lights operation normal; 3 = Lights operate at reduced power; 4 = Lights failed; 5 -7 = reserved for future use
	2	Status of Racon: 0 = no Racon mounted; 1 = Racon mounted, but status not available = default; 2 = Racon operation normal; 3 = Racon failed
	1	Off-Position indicator (for floating Aids-to-Navigation, only): 0 = on position; 1 = off position; Note: This flag shall only be considered valid by receiving station, if the Aid-to-Navigation is a floating aid, and if Time Stamp is equal to or below 59.
	3	Regionally or locally defined status: 0 = regional status not available = default; 1 - 7 = to be determined by regional or local competent authority
Spare	2	Spare. Not used. Shall be set to zero
Number of bits	232	

Table 33

Number	Type of Fixed Aid	Number	Type of Floating Aid
0	Not available = default	16	TBD
1	TBD	17	TBD
2	TBD	18	TBD
3	TBD	19	TBD
4	TBD	20	TBD
5	TBD	21	TBD
6	TBD	22	TBD
7	TBD	23	TBD
8	TBD	24	TBD
9	TBD	25	TBD
10	TBD	26	TBD
11	TBD	27	TBD
12	TBD	28	TBD
13	TBD	29	TBD
14	TBD	30	TBD
15	TBD	31	TBD

Note on Aids-to-Navigation within AIS:

The competent international body for Aids-to-Navigation, IALA, defines an Aid-to-Navigation as: "An aid to navigation is a device or system external to vessels designed and operated to enhance safe and efficient navigation of vessels and/or vessel traffic." (IALA Navguide, Edition 1997, Chapter 7).

The IALA Navguide stipulates: "A floating aid to navigation, which is out of position, adrift or during the night is unlighted, may itself become a danger to navigation. When a floating aid is out of position or malfunctioning, navigational warnings must be given." Therefore, if a station, which transmits Message 5 with an Aids-to-Navigation Static data set, is mounted on a floating Aid-to-Navigation, this station could also transmit Safety Related Broadcast Message (Message 14) upon detecting the floating Aid-to-Navigation has gone out of position or is malfunctioning, at the competent authority's discretion.

#### 7.6.12.4 (M.1371/A2-3.3.8.2.3.4) Data set for Regional Ship Static and Voyage Related Data

If the Data Set Indicator in Message 5 is set to three (3) the Regional Ship Static and Voyage Related data set shall be used to complete Message 5 as defined by a competent regional Authority.

### 7.6.13 (M.1371/A2-3.3.8.2.4) Message 6: Addressed Binary Message

The Addressed Binary Message shall be variable in length, based on the amount of binary data. The length shall vary between 1 and 5 slots. See Application Identifiers in §3.3.8.2.4.1.

**Table 34**

Parameter	Number of bits	Description		
Message ID	6	Identifier for Messages 6; always 6		
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. Shipborne transponders shall use the default value 0 (not repeated); refer to § 4.6.1.1; 0 - 3 ; default = 0; 3 = do not repeat any more.		
Source ID	30	MMSI number of source station		
Sequence Number	2	0 - 3; refer to § 5.4.1		
Destination ID	30	MMSI number of destination station		
Spare	2	Not used. Shall be zero		
Binary Data	Max 936	Application Identifier	16 bits	Shall be as described in § 3.3.8.2.4.1
		Application Data	Max 920 bits	Application specific data
Total Maximum Number of bits	Max 1008	Occupies 1 to 5 slots subject to the length of sub-field Message Content		

Additional bit stuffing will be required for these message types. For details refer to Transport Layer, section 6.5.3.2.

The following table gives the number of binary data bytes (including Application ID and Application Data), so that the whole message fits into a given number of slots. It is recommended that any application optimises the use of slots by limiting the number of binary data bytes to the numbers given, if possible:

**Table 35**

Number of slots	Maximum binary data bytes
1	8
2	36
3	64
4	92
5	120

These numbers take also into account bit stuffing.

#### 7.6.13.1 Application Identifier

Addressed and Broadcast Binary Messages shall contain a 16-bit application identifier, structured as follows:

**Table 36**

Bit	Description
15-6	Designated Area Code. This code shall be identical to the Maritime Identification Digits (MID), as defined by ITU-R, which are the leading three digits of the MMSI, with the exemptions for NULL and International Application Identifier given below. The length shall be 10 bits.
5-0	Function Identifier. The meaning shall be determined by the competent authority which is responsible for the area given in the designated area code. The length shall be 6 bits.

Whereas the Application Identifier allows for regional and local applications, the Application Identifier shall have the following special values, which shall apply to all stations in order to guarantee international compatibility.

#### 7.6.13.2 NULL Application Identifier

The NULL Application Identifier shall be used for local testing purposes. It shall be identified by a Designated Area Code (bits 15 - 6 of Application Identifier) of 0 (zero). The function code shall be arbitrary.

#### 7.6.13.3 International Application Identifier

The International Application Identifier shall be used for applications, which are of global relevance. See table below. Different international applications are separated by the use of function identifiers.

**Table 37**

<b>Designated Area Code</b>	<b>Function Identifier</b>	<b>Resulting Application Identifier (Binary)</b>	<b>Resulting Application Identifier (Hex)</b>	<b>Description</b>
001	00	0000 0000 0100 0000	0040	.
001	01	0000 0000 0100 0001	0041	
001	02	0000 0000 0100 0010	0042	
001	03	0000 0000 0100 0011	0043	
001	...	0000 0000 01XX XXX	...	
001	63	0000 0000 0111 1111	007F	

#### 7.6.14 (M.1371/A2-3.3.8.2.5) Message 7: Binary Acknowledge

Message 7 and Message 13: Safety Related Acknowledge are identical.

Message 7 shall be used as an acknowledgement of up to 4 Messages 6 received (refer to section 6.5.4.1) and shall be transmitted on the channel, where the addressed message, to be acknowledged, was received.

Message 13 shall be used as an acknowledgement of up to 4 Messages 12 received (refer to section 6.5.4.1) and shall be transmitted on the channel, where the addressed message, to be acknowledged, was received.

These acknowledgements shall be applicable only to the VHF data link (refer to section 6.5.4.1). Other means must be employed for acknowledging applications.

**Table 38**

<b>Parameter</b>	<b>Number of bits</b>	<b>Description</b>
Message ID	6	Identifier for Messages 7, 13 7 = Binary Acknowledge; 13 = Safety Related Acknowledge
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. Shipborne transponders shall use the default value 0 (not repeated); refer to § 4.6.1.1. 0 - 3 ; default = 0; 3 = do not repeat any more.
Source ID	30	MMSI number of source of this ACK
Spare	2	Not used. Shall be set to zero
Destination ID1	30	MMSI number of first destination of this ACK

Sequence Number for ID1	2	Sequence number of message to be acknowledged; 0 - 3.
Destination ID2	30	MMSI number of second destination of this ACK; shall be omitted if no Destination ID2.
Sequence Number for ID2	2	Sequence number of message to be acknowledged; 0 - 3.; shall be omitted if no Destination ID2.
Destination ID3	30	MMSI number of third destination of this ACK; shall be omitted if no Destination ID3.
Sequence Number for ID3	2	Sequence number of message to be acknowledged; 0 - 3.; shall be omitted if no Destination ID3.
Destination ID4	30	MMSI number of third destination of this ACK; shall be omitted if no Destination ID3
Sequence Number for ID4	2	Sequence number of message to be acknowledged; 0 - 3. Shall be omitted if there is no Destination ID4
Total Number of bits	72 - 168	

#### 7.6.15 (M.1371/A2-3.3.8.2.6) Message 8: Binary Broadcast Message

*This message shall be variable in length, based on the amount of binary data. The length shall vary between 1 and 5 slots.*

**Table 39**

Parameter	Number of bits	Description		
Message ID	6	Identifier for Message 8; always 8		
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. Shipborne transponders shall use the default value 0 (not repeated); refer to § 4.6.1.1.  0 - 3 ; default = 0; 3 = do not repeat any more.		
Source ID	30	MMSI number of source station		
Spare	2	Not used. Shall be set to zero		
Binary Data	Max 968	Application Identifier	16 bits	Shall be as described in 6.3.3.8.2.4.1
		Application Data	Max 952 bits	Application specific data
Total Number of bits	Max 1008	Occupies 1 to 5 slots.		

The following table gives the number of binary data bytes (including Application ID and Application Data), so that the whole message fits into a given number of slots. It is recommended that any application optimises the use of slots by limiting the number of binary data bytes to the numbers given, if possible:

**Table 40**

Number of slots	Maximum binary data bytes
1	12
2	40
3	68
4	96
5	124

*These numbers take also into account bit stuffing.*

*Additional bit stuffing will be required for this message type. For details refer to Transport Layer, section 6.5.3.2.*

### 7.6.16 Message 9: Special Position Report

*This message shall be used as a Special Position Report for SAR and other regional applications for stations other than ships.*

**Table 41**

<b>Parameter</b>	<b>Number of Bits</b>	<b>Description</b>
Message Id	6	Identifier for this message 1, 2 or 3
DTE	1	Data terminal ready (0 = available 1 = not available = default)
Data indicator	1	Indicates data available to transmit (0 = not available = default, 1 = available)
User ID	30	MMSI number
Altitude (GNSS)	12	Altitude (derived from GNSS) expressed in meter (0 – 4094 meter) 4095 = not available, 4094 = 4094 meter or higher
SOG	10	Speed over ground in knot steps (0-1022 knots) 1023 = not available, 1022 = 1022 knots or higher
Position accuracy	1	1 = high (< 10 m; Differential Mode of e.g. DGNSS receiver) 0 = low (>10 m; Autonomous Mode of e.g. GNSS receiver or of other Electronic Position Fixing Device); default = 0
Longitude	28	Longitude in 1/10 000 min ( $\pm$ 180 degrees, East = positive, West = negative. 181 degrees (6791 ACO hex) = not available = default
Latitude	27	Latitude in 1/10 000 min ( $\pm$ 90 degrees, North = positive, South = negative, 91 degrees (3412140 hex) = not available = default)
COG	12	Course over ground in 1/10° (0-3599), 3600 (E10hex) = not available = default; 3601 – 4095 shall not be used
Time stamp	6	UTC second when the report was generated (0-59, or 60 if time stamp is not available, which shall also be the default value, or 62 if Electronic Position Fixing System operates in estimated (dead reckoning) mode, or 61 if positioning system is in manual input mode or 63 if the positioning system is inoperative)
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. Shipborne transponders shall use the default value 0 (not repeated), refer to § 4.6.1.1. 0 - 3 ; default = 0; 3 = do not repeat any more.
		.
Reserved for regional applications	13	Reserved for definition by a competent regional authority. Shall be set to zero, if not used for any regional application. Regional applications shall not use zero.
Spare	1	Not used. Shall be set to zero
Communication State	18	SOTDMA (refer to § 3.3.7.2.2).
Total number of bits	168	

### 7.6.17 (M.1371/A2-3.3.8.2.7) Message 10: UTC and Date Inquiry

*This message shall be used when a station is requesting UTC and date from another station.*

**Table 42**

<b>Parameter</b>	<b>Number of bits</b>	<b>Description</b>
Message ID	6	Identifier for Message 10; always 10
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. Shipborne transponders shall use the default value 0 (not repeated); refer to 6.4.6.1.1; 0 - 3 ; default = 0; 3 = do not repeat any more.
Source ID	30	MMSI number of station which inquires UTC
Spare	2	Not used. Shall be set to zero
Destination ID	30	MMSI number of station which is inquired
Spare	2	Not used. Shall be set to zero.
Total Number of bits	72	

#### 7.6.18 (M.1371/A2-3.3.8.2.2) Message 11: UTC and Date Response

For Message 11 refer to description of Message 4.

Message 11 is only transmitted as a result of a UTC Request message (Message 10). The UTC and Date response shall be transmitted on the channel, where the UTC request message was received.

#### 7.6.19 (M.1371/A2-3.3.8.2.4) Message 12: Addressed Safety Related Message

The Addressed Safety Related Message shall be variable in length, based on the amount of safety related text. The length shall vary between 1 and 5 slots.

**Table 43**

<b>Parameter</b>	<b>Number of bits</b>	<b>Description</b>
Message ID	6	Identifier for Messages 12; always 12
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. Shipborne transponders shall use the default value 0 (not repeated); refer to 6.4.6.1.1. 0 - 3 ; default = 0; 3 = do not repeat any more.
Source ID	30	MMSI number of station which is the source of the message
Sequence Number	2	0 - 3; refer to 6.5.4.1
Destination ID	30	MMSI number of station which is the destination of the message
Spare	2	Not used. Shall be zero
Safety related text	Max 936	6-bit ASCII.
Total Maximum Number of bits	Max 1008	Occupies 1 to 5 slots subject to the length of text

Additional bit stuffing will be required for this message type. For details refer to Transport Layer, 6.5.3.2.

The following table gives the number of 6-bit-ASCII characters, so that the whole message fits into a given number of slots. It is recommended that any application optimises the use of slots by limiting the number of characters to the numbers given, if possible:

**Table 44**

<b>Number of slots</b>	<b>Maximum 6-bit-ASCII characters</b>
1	10
2	48

3	85
4	122
5	160

*These numbers take also into account bit stuffing.*

#### **7.6.20 (M.1371/A2-3.3.8.2.5) Message 13: Safety Related Acknowledge**

Message 13 and Message 7 are identical. *For Message 13 refer to description of Message 7.*

#### **7.6.21 (M.1371/A2-3.3.8.2.6) Message 14: Safety Related Broadcast Message,**

*The Safety Related Broadcast Message shall be variable in length, based on the amount of safety related text. The length shall vary between 1 and 5 slots.*

**Table 45**

<i>Parameter</i>	<i>Number of bits</i>	<i>Description</i>
<b>Message ID</b>	<b>6</b>	<b>Identifier for message 14; always 14</b>
<b>Repeat Indicator</b>	<b>2</b>	<b>Used by the repeater to indicate how many times a message has been repeated. Shipborne transponders shall use the default value 0 (not repeated); refer to 6.4.6.1.1.</b>  <b>0 - 3 ; default = 0; 3 = do not repeat any more.</b>
<b>Source ID</b>	<b>30</b>	<b>MMSI number of source station of message</b>
<b>Spare</b>	<b>2</b>	<b>Not used. Shall be set to zero</b>
<b>Safety related Text</b>	<b>Max 968</b>	<b>6-bit ASCII.</b>
<b>Total Number of bits</b>	<b>Max 1008</b>	<b>Occupies 1 to 5 slots subject to the length of text</b>

*Additional bit stuffing will be required for this message type. For details refer to Transport Layer, 6.5.3.2.*

The following table gives the number of 6-bit ASCII characters, so that the whole message fits into a given number of slots. It is recommended that any application optimises the use of slots by limiting the number of characters to the numbers given, if possible:

**Table 46**

<b>Number of slots</b>	<b>Maximum 6-bit-ASCII characters</b>
1	16
2	53
3	90
4	128
5	165

*These numbers take also into account bit stuffing.*

#### **7.6.22 (M.1371/A2-3.3.8.2.8) Message 15: Interrogation**

*The Interrogation Message shall be used for interrogations via the VHF TDMA link other than UTC and date requests. The response shall be transmitted on the channel where the interrogation was received.*

*A mobile station can be interrogated for message identifiers 1 and 5, by another station. A base station can be interrogated for message identifiers 4, 17, 20 and 22.*

*The parameter "Slot Offset" shall be set to zero, if slot shall autonomously be allocated by the responding station. If a "Slot Offset" is given, it shall be relative to the start slot of this transmission. There shall be the following four (4) possibilities to use this message:*

- 1) One (1) station is interrogated one (1) message: The parameters Destination ID1, Message ID1.1 and Slot Offset 1.1 shall be defined. All other parameters shall be omitted.
- 2) One (1) station is interrogated two (2) messages: The parameters Destination ID1, Message ID1.1, Slot Offset 1.1, Message ID1.2, and Slot Offset 1.2 shall be defined. The parameters Destination ID2, Message ID2.1, and Slot Offset 2.1 shall be omitted.
- 3) The first station and the second station are interrogated one (1) message each: The parameters Destination ID1, Message ID1.1, Slot Offset 1.1, Destination ID2, Message ID2.1, and Slot Offset 2.1 shall be defined. The parameters Message ID1.2 and Slot Offset 1.2 shall be set to zero (0).
- 4) The first station is interrogated two (2) messages, and the second station is interrogated one (1) message: All parameters shall be defined.

**Table 47**

<b>Parameter</b>	<b>Number of bits</b>	<b>Description</b>
Message ID	6	Identifier for Message 15; always set to 15
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. Shipborne transponders shall use the default value 0 (not repeated). 0 - 3 ; default = 0; 3 = do not repeat any more, refer to 6.4.6.1.1.
Source ID	30	MMSI number of interrogating station
Spare	2	Not used. Shall be set to zero
Destination ID 1	30	MMSI number of first interrogated station
Message ID 1.1	6	First requested message type from first interrogated station
Slot offset 1.1	12	Response slot offset for first requested message from first interrogated station.
Data Set Indicator 1.1	2	Used if first interrogated message from first interrogated station is Ship Static and Voyage Related Data Message 5; otherwise set to zero
Message ID 1.2	6	Second requested message type from first interrogated station.
Slot offset 1.2	12	Response slot offset for second requested message from first interrogated station.
Data Set Indicator 1.2	2	Used if second interrogated message from first interrogated station is Ship Static and Voyage Related Data Message 5; otherwise set to zero

Destination ID 2	30	MMSI number of second interrogated station.
Message ID 2.1	6	Requested message type from second interrogated station.
Slot offset 2.1	12	Response slot offset for requested message from second interrogated station.
Data Set Indicator 2.1	2	Used if interrogated message from second interrogated station is Ship Static and Voyage Related Data Message 5; otherwise set to zero
Total Number of bits	88 - 160	Total number of bits depends upon number of messages requested.

### 7.6.23 Message 16: Assigned Mode Command

Assignment shall be transmitted by a base station when operating as a controlling entity. Other stations can be assigned a transmission schedule, other than the currently used one. If a station is assigned a schedule, it will also enter assigned mode.

Two stations can be assigned simultaneously.

When receiving an assignment, the station shall tag it with a timeout, randomly selected between 4 and 8 minutes.

Note: A base station shall monitor the mobile station's transmissions in order to determine when the mobile station will time out.

**Table 48**

Parameter	Number of Bits	Description
Message ID	6	Identifier for this message. Always 16
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. Shipborne transponders shall use the default value 0 (not repeated); refer to 6.4.6.1.1. 0 - 3 ; default = 0; 3 = do not repeat any more.
Source ID	30	MMSI of assigning station.
Spare	2	Spare. Shall be set to zero.
Destination ID A	30	MMSI Number. Destination identifier A.
Slot Offset A	12	Slot Offset from current slot to first assigned slot (1).
Increment A	10	Slot Increment to next assignment. (1)
Destination ID B	30	MMSI Number. Destination identifier B. Shall be omitted if there is assignment to station A, only.
Slot Offset B	12	Slot Offset from current slot to first assigned slot. Shall be omitted if there is assignment to station A, only (1).
Increment B	10	Slot Increment to next assignment (1). Shall be omitted, if there is assignment to station A, only.
Spare	Max 4	Spare. Not used. Shall be set to zero. The number of spare bits which shall be 0 or 4 shall be adjusted in order to observe byte boundaries.
Total	96 or 144	Shall be 96 or 144 bits.

Footnote:

(1)To assign a reporting rate for a station, the parameter "Increment" shall be set to zero. The parameter "Slot Offset" shall then be interpreted as the number of reports in a time interval of 10 minutes.

The base station making the assignment to the mobile station shall consider the time out behaviour of the mobile station when assigning this value.

### 7.6.24 (M.1371/A2-3.3.8.2.9) Message 17: DGNSS Broadcast Binary Message

This message shall be transmitted by a base station, which is connected to a DGNSS reference source, and configured to provide DGNSS data to receiving stations. The contents of the data shall be in accordance with ITU-R M.823-3, excluding parity formatting.

**Table 49**

<b>Parameter</b>	<b>Number of bits</b>	<b>Description</b>
Message ID	6	Identifier for Message 17; always 17
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. Shipborne transponders shall use the default value 0 (not repeated), refer to 6.4.6.1.1. 0 - 3 ; default = 0; 3 = do not repeat any more.
Source ID	30	MMSI of the base station.
Spare	2	Spare. Shall be set to zero.
Longitude	18	Longitude of DGNSS reference station in 1/10 minute ( $\pm 180$ degrees, East = positive, West = negative)
Latitude	17	Latitude of DGNSS reference station in 1/10 minute ( $\pm 90$ degrees, North = positive, South = negative)
Spare	5	Not used. Shall be set to zero
Data	736	Differential Correction data (see below)
Total Number of bits	816	

The Differential Correction data section *shall* be organised as listed below:

**Table 50**

<b>Parameter</b>	<b>Number of bits</b>	<b>Description</b>
Message Type	6	Recommendation ITU-R M.823-3;
Station ID	10	Recommendation ITU-R M.823-3 Station identifier
Z Count	13	Time value in 0.6 seconds (0-3599.4)
Sequence Number	3	Message sequence number (cyclic 0-7)
N	5	Number of DGNSS data words following the two word header, up to a maximum of 29
Health	3	Reference station health (specified in Recommendation ITU-R M.823-3)
DGNSS data word	N*24	DGNSS message data words excluding parity
Total Number of bits	736	Assuming N = 29 (the maximum value)

Note 1: It is necessary to restore parity in accordance with Recommendation ITU-R M.823-2 before using this message to differentially correct GNSS Positions to DGNSS Positions.

Note 2: Where DGNSS corrections are received from multiple sources the DGNSS corrections from the nearest DGNSS reference station shall be used taking into account the health and the Z count of the DGNSS reference station.

Note 3: Transmissions of Message 17 by base stations shall take into account ageing, update rate and the resulting accuracy of the DGNSS service. Because of the resulting effects of VDL channel loading, the transmission of Message 17 shall be no more than necessary to provide the necessary DGNSS service accuracy.

#### **7.6.25 (M.1371/A2-3.3.8.2.6) Message 19: VTS Targets (targets derived by means other than AIS)**

This message shall be used to transmit VTS targets. This message shall be variable in length, based on the amount of VTS targets. The length shall vary between 1 and 5 slots. Because of the resulting effects of VDL channel loading, the transmission of Message 19 shall be no more than necessary to provide the necessary level of safety.

**Table 51**

<b>Parameter</b>	<b>Number of bits</b>	<b>Description</b>
Message ID	6	Identifier for Message 19; always 19
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. Shipborne transponders shall use the default value 0 (not repeated); refer to 6.4.6.1.1. 0 - 3 ; default = 0; 3 = do not repeat any more.

Source ID	30	MMSI number of source station
Spare	2	Not used. Shall be set to zero
Binary Data	Max 960	1 up to 8 VTS targets, each structured as defined in Table below
Total Number of bits	Max 1000	Occupies 1 to 5 slots.

Additional bit stuffing will be required for this message type. For details refer to Transport Layer, 6.5.3.2.

Each VTS Target in the Binary Data Field shall be structured as follows:

**Table 52**

Parameter	Bits	Description
Type of Target Identifier	2	Identifier Type; 0 = The target identifier shall be the MMSI number. 1 = The target identifier shall be the IMO number. 2 = The target identifier shall be the call sign. 3 = Other (default).
Target ID	42	Target Identifier. The Target ID shall depend on Type of Target Identifier above. When call sign is used, it shall be inserted using 6-bit ASCII. If Target Identifier is unknown, this field shall be set to zero. When MMSI or IMO number is used, the least significant bit shall equal bit zero of the Target ID.
Spare	4	Spare. Shall be set to zero.
Latitude	24	Latitude in 1/1000 of a minute.
Longitude	25	Longitude in 1/1000 of a minute.
COG	9	Course over ground in degrees (0-359); 360 = not available = default.
Time Stamp	6	UTC second when the report was generated (0-59, or 60 if time stamp is not available, which shall also be the default value, or 61 if positioning system is in manual input mode or 62 if positioning system operates in estimated (dead reckoning) mode, or 63 if positioning system is inoperative,).
SOG	8	Speed over ground in knots; 0-254; 255 = not available = default.
Total	120	1 to 8 targets possible in Message 19.

A VTS target shall only be used, when the position of the target is known. However, the target identity and/or course and/or time stamp and/or speed over ground may be unknown.

#### **7.6.26 M.1371/A2-3.3.8.2.10) Message 20: Data Link Management Message**

This message shall be used by base station(s) to pre-announce the fixed allocation schedule (FATDMA) for one or more base station(s) and it shall be repeated as often as required. In this way the system can provide a high level of throughput for base station(s). This is especially important in regions where several base stations are located adjacent to each other and mobile station(s) move between these different regions.

The mobile station shall then reserve the slots for transmission by the base station(s) until time-out occurs. The base station shall refresh the time out value with each transmission of Message 20 in order to allow mobile stations to terminate their reservation for the use of the slots by the base stations (refer to 6.3.3.1.2).

The parameters "Slot Offset Number", "Number of Slots", "Time Out", and "Increment" shall be treated as a unit, meaning that if one parameter is defined all other parameters shall be defined within that unit. The parameter "Slot Offset Number" shall denote the offset from the slot in which Message 20 was received to the first slot to be reserved. The parameter "Number of Slots" shall denote the number of consecutive slots to be reserved starting with the first reserved slot. This defines a reservation block. The parameter "Increment" shall denote the number of slots between the starting slot of each reservation block. If "Increment" is set to zero, there shall be no additional reservation blocks.

**Table 53**

<b>Parameter</b>	<b>Number of bits</b>	<b>Description</b>
Message ID	6	Identifier for Message 20; always 20
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. Shipborne transponders shall use the default value 0 (not repeated); refer to 6.4.6.1.1; 0 - 3 ; default = 0; 3 = do not repeat any more.
Source Station ID	30	MMSI number of base station
Spare	2	Not used. Shall be set to zero
Slot offset number 1	12	Reserved slot offset number
Number of slots 1	4	Number of reserved consecutive slots: 1 - 15
Time out 1	3	Time out value in minutes
Increment 1	11	Increment to repeat reservation block 1
Slot offset number 2	12	Reserved slot offset number (Optional)
Number of slots 2	4	Number of reserved consecutive slots: 1 - 15; optional
Time out 2	3	Time out value in minutes (optional)
Increment 2	11	Increment to repeat reservation block 2 (optional)
Slot offset number 3	12	Reserved slot offset number (optional)
Number of slots 3	4	Number of reserved consecutive slots: 1 - 15; optional
Time out 3	3	Time out value in minutes (optional)
Increment 3	11	Increment to repeat reservation block 3 (optional)
Slot offset number 4	12	Reserved slot offset number (optional)
Number of slots 4	4	Number of reserved consecutive slots: 1 - 15; optional
Time out 4	3	Time out value in minutes (optional)
Increment 4	11	Increment to repeat reservation block 4 (optional)
Spare	Max 6	Not used. Shall be set to zero. The number of spare bits which may be 0, 2, 4, or 6 shall be adjusted in order to observe byte boundaries.
Total Number of bits	72 - 160	

**7.6.27 (M.1371/A2-3.3.8.2.6) Message 21: Test/Evaluation Message**

To ensure system integrity in an operational system, the Test/Evaluation Message shall be used. This message shall be used for that purpose. This message shall be variable in length, between 1 and 5 slots, based on the amount of proprietary binary data. .

**Table 54**

<b>Parameter</b>	<b>Number of bits</b>	<b>Description</b>
Message ID	6	Identifier for message 21; always 21
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. Shipborne transponders shall use the default value 0 (not repeated); refer to 6.4.6.1.1. 0 - 3 ; default = 0; 3 = do not repeat any more.
Source ID	30	MMSI number of source station
Spare	2	Not used. Shall be set to zero
Binary Data	Max 968	Proprietary Binary Data
Total Number of bits	Max 1008	Occupies 1 to 5 slots.

The following table gives the number of proprietary binary data bytes, so that the whole message fits into a given number of slots:

**Table 55**

<b>Number of slots</b>	<b>Maximum proprietary binary data bytes</b>
1	12
2	40
3	68
4	96
5	124

*These numbers take also into account bit stuffing.*

*Additional bit stuffing will be required for this message type. For details refer to Transport Layer, 6.5.3.2.*

If possible, it is recommended that any application optimises the use of slots by limiting the number of proprietary binary data bytes to the numbers given.

#### **7.6.28 (M.1371/A2-3.3.8.2.11) Message 22: Channel Management**

This message shall be transmitted by a base station to command the VHF data link parameters for the geographical area designated in this message. The geographical area designated by this message shall be as defined in 6.4.1.

When a station is subject to the regional boundaries as defined in this message it shall immediately set its operating frequency channel numbers, its Tx/Rx mode, its power level, and its training sequence length to the values as commanded by this message. When a station is not subject to the regional boundaries as defined in this message the station shall utilise the default settings, which are defined in the following paragraphs:

Length of training sequence:	6.2.6
Power settings:	6.2.13
Operating frequency channel numbers:	6.4.1.1.
Tx/Rx Mode:	6.4.1.2

**Table 56**

<b>Parameter</b>	<b>Number of bits</b>	<b>Description</b>
Message ID	6	Identifier for Message 22; always 22
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. Shipborne transponders shall use the default value 0 (not repeated); refer to 6.4.6.1.1. 0 - 3 ; default = 0; 3 = do not repeat any more.
Station ID	30	MMSI number of base station
Spare	2	Not used. Shall be set to zero.
Channel 1	12	Channel number according to Recommendation ITU-R M.1084-3, Annex4. Note: The channel number also defines the channel bandwidth (refer to 6.4.1.3)
Channel 2	12	Channel number according to Recommendation ITU-R M.1084-3, Annex4. Note: The channel number also defines the channel bandwidth (refer to 6.4.1.3)
Tx/Rx Mode	4	0=Tx1/Tx2, Rx1/Rx2 (default) 1=Tx1, Rx1/Rx2 2=Tx2, Rx1/Rx2 3 - 15: not used
Power	1	0=High (default), 1=Low

Longitude 1	18	Longitude of area to which the assignment applies; upper right corner (north east); in 1/10 minute ( $\pm 180$ degrees, East = positive, West = negative)
Latitude 1	17	Latitude of area to which the assignment applies; upper right corner (north east); in 1/10 minute ( $\pm 90$ degrees, North = positive, South = negative)
Longitude 2	18	Longitude of area to which the assignment applies; lower left corner (south west); in 1/10 minute ( $\pm 180$ degrees, East = positive, West = negative)
Latitude 2	17	Latitude of area to which the assignment applies; lower left corner (south west); in 1/10 minute ( $\pm 90$ degrees, North = positive, South = negative)
Training sequence	1	Assignment of Length of Training Sequence 0 = 24 bit (default), 1 = 32 bit
Spare	28	Not used. Shall be set to zero.
Total Number of bits	168	

## 7.7 Network layer

The network layer shall be used for:

- 1) establishing and maintaining channel connections;
- 2) management of priority assignments of messages;
- 3) distribution of transmission packets between channels;
- 4) data link congestion resolution.

### 7.7.1 (M.1371/A2-4.1) Dual Channel operation and Channel management

Requirements for dual channel operation (reference 6.2.1.5), shall apply, unless otherwise specified by Message 22.

#### 7.7.1.1 (M.1371/A2-4.1.1) Operating frequency channels

##### 7.7.1.1.1

Two frequency channels have been designated in RR Appendix S 18 for AIS use worldwide, on the high seas and in all other areas. The two designated frequencies are

AIS 1 (Channel 87B, 161.975 MHz), (2087)\* and

AIS 2 (Channel 88B, 162.025 MHz) (2088)\*.

##### 7.7.1.1.2

*The AIS shall default to operation on these channels. Other frequencies are designated on a regional basis for AIS purposes.*

##### 7.7.1.1.3

Operation on other channels *shall* be accomplished by one of three means: Manual input commands (manual switching), TDMA commands from a base station (automatic switching by TDMA telecommand), or DSC commands from a base station (automatic switching by DSC telecommand).

### 7.7.1.2 (M.1371/A2-4.1.2) Normal default mode

#### 7.7.1.2.1

The normal default mode of operation *shall* be a two-channel operating mode, where the AIS simultaneously receives on both channels in parallel. In order to accomplish this performance, the

\* See Recommendation ITU-R M.1084-3, Annex 4

AIS transponder *shall* contain two TDMA receivers. Channel access is performed independently on each of the two parallel channels.

For periodic repeated messages, including the initial link access, the transmissions *shall* alternate between AIS 1 and AIS 2. This alternating behaviour is on a transmission by transmission basis, without respect to time frames.

Transmissions following slot allocation announcements, responses to interrogations, responses to requests, and acknowledgements shall be transmitted on the same channel as the initial message.

For addressed messages, transmissions shall utilise the channel in which messages from the addressed station was last received.

For non-periodic messages other than those referenced above, the transmissions of each message, regardless of message type, shall alternate between AIS 1 and AIS 2.

Base stations could alternate their transmissions between AIS 1 and AIS 2 for the following reasons:

- To increase link capacity;
- To balance channel loading between AIS 1 and AIS 2; and
- to mitigate the harmful effects of RF interference.

When a base station is included in a channel management scenario, it shall transmit addressed messages on the channel in which it last received a message from the addressed station.

#### **7.7.1.3 (M.1371/A2-4.1.3) Regional operating frequencies**

Regional operating frequencies *shall* be designated by the four-digit channel numbers specified in Recommendation ITU-R M.1084-3, Annex 4. This allows for simplex, duplex, 25 kHz and 12.5 kHz channels for regional options, subject to the provisions of Appendix S18 of the Radio Regulations.

The channel number designates the use of the channel (simplex, duplex, 25 kHz and 12.5 kHz).

A mobile station shall use a duplex channel in half-duplex mode. A base station may use a duplex channel in either full-duplex or half-duplex mode.

#### **7.7.1.4 (M.1371/A2-4.1.4) Regional operating areas**

Regional operating areas *shall* be designated by a Mercator projection rectangle with two reference points (WGS-84). The first reference point *shall* be the geographical coordinate address of the north-eastern corner (to the nearest tenth of a minute) and the second reference point *shall* be the geographical coordinate address of the south-western corner (to the nearest tenth of a minute) of the rectangle.

#### **7.7.1.5 (A2-4.1.5) Transitional mode operations near regional boundaries**

##### **7.7.1.5.1**

The AIS device *shall* automatically switch to the two-channel transitional operating mode when it is located within five nautical miles of a regional boundary. In this mode the AIS device *shall* transmit and receive on the primary AIS frequency specified for the occupied region, and it *shall* also transmit and receive on the primary AIS frequency of the nearest adjacent region. Only one transmitter is required. Additionally, *for dual channel operations as specified in 6.4.1, except when the reporting rate has been assigned by Message 16*, when operating in this mode, the reporting rate *shall* be doubled and shared between the two channels (alternate transmission mode).

##### **7.7.1.5.2**

Regional boundaries *shall* be established by the competent authority in such a way that this two-channel transitional operating mode can be implemented as simply and safely as possible. For example, care *shall* be taken so as to avoid having more than three adjacent regions at any

regional boundary intersection. The high seas area *shall* be considered to be a region. Regions *shall* be as large as possible. For practical purposes, in order to provide safe transitions between regions, these *shall* be no smaller than 20 nautical miles on any boundary side. Examples of acceptable and unacceptable regional boundary definitions are illustrated below:

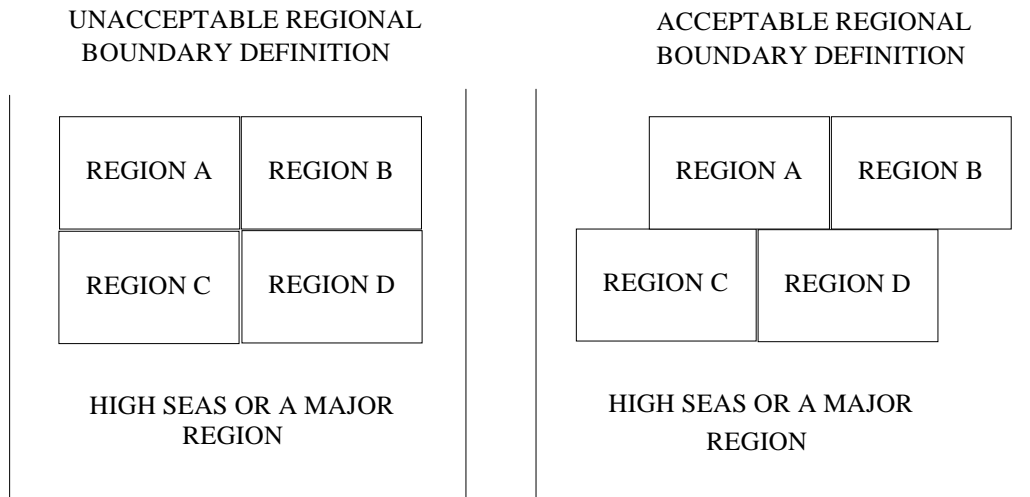


Figure 19

#### 7.7.1.6 (M1371/A2-4.1.6) Channel management by manual input

Channel management by manual input shall include the geographical area along with the designated AIS channel (s) for use in that area (refer to Message 22). Manual input shall be subject to override by either Message 22 or DSC channel Management. The last command shall override any previous channel management command.

#### 7.7.2 (M.1371/A2-4.2) Distribution of transmission packets

##### 7.7.2.1 (M.1371/A2-4.2.1) The user directory

The user directory *shall be* internal to the AIS which is a directory of all users that the station receives (Transponder IDs, bearing and distance, relative speed, 30 minute + history). **[TBD]**

##### 7.7.2.2 (M.1371/A2-4.2.2) Routing of transmission packets

*The following tasks are fulfilled with regard to packet routing*

- 1) Position reports shall be distributed to the Presentation Interface.
- 2) Own position shall be reported to the Presentation Interface and transmitted over the VHF data link.
- 3) A priority is assigned to messages, if message queuing is necessary.
- 4) Received GNSS corrections are output to the Presentation Interface.

##### 7.7.2.3 (M.1371/A2-4.2.3) Management of Priority Assignments for Messages

There are 4 (four) levels of message priority, namely:

- **Priority 1 (highest priority):** Critical link management messages including position report messages in order to ensure the viability of the link.
- **Priority 2 (highest service priority):** Safety related messages. These messages shall be transmitted with a minimum of delay .
- **Priority 3:** Assignment, interrogation and responses to interrogation messages.
- **Priority 4 (lowest priority):** All other messages.

For details refer to Table 13.

The above priorities are assigned to the relevant type of messages, thereby providing a mechanism for sequencing specific messages in order of priority. The messages are serviced in order of priority. This applies to both messages received and messages to be transmitted. Messages with the same priority are dealt with in a FIFO (first-in/first-out) order.

### **7.7.3 (M.1371/A2-4.3) Reporting rates**

The parameter Reporting Rate (RR) shall be as defined in 6.3.3.4.4.2 and shall be directly related to reporting interval as defined in Table 1. RR shall be determined by the Network Layer, either autonomously or as a result of an assignment by a competent authority (refer to 6.3.3.6). The default value of the Reporting Rate shall be 5 reports per frame (equivalent to a reporting interval of 12 seconds (refer to Table 1). A shipborne station shall, when accessing the VDL for the first time (refer to 6.3.3.5.2) use the default value. When a mobile station uses a report rate of less than one report per frame, it shall use ITDMA for scheduling. Otherwise SOTDMA shall be used.

#### **7.7.3.1 (M.1371/A2-4.3.1) Autonomously changed reporting rate (continuous and autonomous mode)**

##### **7.7.3.1.1 Speed**

The Reporting Rate (RR) shall be affected by changes of speed as described in this section. Speed shall be determined by Speed over Ground (SOG). When an increase in speed results in a higher RR (refer to Table 1) than the currently used RR, the station shall increase the RR using the algorithm described in 6.3.3.5. When a station has maintained a speed, which shall result in a RR lower than the currently used RR, the station shall reduce RR when this state has persisted for 4 minutes.

##### **7.7.3.1.2 Changing Course**

When a ship changes course, a higher update rate shall be required according to Table 1. Reporting Rate (RR) shall be affected by changing course as described in this section.

A change of course shall be determined by calculating the mean value of the heading information (HDG) for the last 30 seconds and comparing the result with the present heading. When HDG is unavailable the RR shall not be affected.

If the difference exceeds 5°, a higher RR shall be applied in accordance with Table 1. The higher RR shall be maintained by using ITDMA to complement SOTDMA scheduled transmissions in order to derive the desired RR.

The increased Reporting Rate shall be maintained until the difference between the mean value of heading and present heading has been less than 5° for more than 20 seconds.

##### **7.7.3.1.3 (M.1371/A2-4.3.2) Navigational status**

Reporting Rate (Rr) shall be affected by navigational status (refer to 5.4.1.2) as described in this section. When the vessel is at anchor, moored, not under command or aground, which is indicated by the navigational status, Message 3 shall be used with a Reporting Rate of 3 minutes. The navigational status shall be set by the user via the appropriate user interface. The transmission of Message 3 shall be interleaved three (3) minutes after Message 5. The Rr shall be maintained until the navigational status is changed.

#### **7.7.3.2 Assigned Reporting Rates**

A competent authority may assign a Reporting Rate to any mobile station by transmitting Assignment Message 16 from a base or repeater station. An assigned reporting rate shall have precedence over all other reasons for changing reporting rate.

### **7.7.4 (M.1371/A2-4.4) Data link congestion resolution**

When the data link is loaded to such a level that the transmission of safety information is jeopardised, *one of the following methods shall* be used to resolve the congestion.

#### 7.7.4.1 (M.1371/A2-4.4.1) Intentional Slot Reuse by the own station

A station shall reuse time slots only in accordance with this section.

When selecting new slots for transmission, the station shall select from its candidate slot set (refer to 6.3.3.1.2) within the desired selection interval. When the candidate slot set has less than 4 slots, the station shall intentionally reuse slots, used by other shipborne stations only, in order to make the candidate slot set equal to 4 slots. The intentionally reused slots shall be taken from the most distant station(s) within the selection interval. Slots allocated or used by base stations shall not be used unless the base station is located over 120 nautical miles from the own station. When a distant station has been subject to intentional slot reuse, that station shall be excluded from further intentional slot reuse during a time period equal to one frame.

The intentional slot reuse shall be performed as indicated in Figure 4.4.1 below, which is an example, using an example status of slot use on the both operating frequency channels:

			<div>Selection Interval (SI)</div>										
			1	2	3	4	5	6	7	8	9		
Channel 1			F	F	F	D	D	F	F	X	B		
Channel 2			F	D	E	F	I	X	O	X	X		

Figure 20

Legend:

*It is intended to intentionally reuse one slot within the Selection Interval of frequency channel 1. The current status of the use of the slots within the Selection Interval on both frequency channels 1 and 2 is given as follows:*

F = Free

I = Internally allocated (allocated by own station, not in use)

E = Externally allocated (allocated by another station near own station)

B = Allocated by a base station within 120 nautical miles of own station

D = Allocated by another station far away from own station

E = Internally allocated (allocated by own station, in use presently)

X = Should not be used

The slot for intentional slot reuse should then be selected by the following priority (indicated by the number of the slot combination as given in the figure above):

Highest Selection Priority: No. 1

No. 2

No. 4

Lowest Selection Priority No. 5

Combinations 3, 6, 7, 8 and 9 should not be used.

Rationale for not using slot combinations:

No. 3 Allocated by another near station

No. 6 Adjacent slot rule

No. 7 Opposite channel rule

No. 8 Adjacent slot rule

No. 9 Base station rule

### **7.7.5 (M.1371/A2-4.4) Data link congestion resolution**

A base station may assign Reporting Rates to shipborne stations and can thus protect the viability of the VDL.

### **7.7.6 (M.1371/A2-4.5) Base Station Operation**

*A base station accomplishes the following tasks, additional to a mobile station:*

- 1) *provide synchronisation for stations not directly synchronised: Emit Base Station Reports (Message 4) with the default update rate of once per one (1) minute (refer to 6.3.1.1.3),*
- 2) *provide transmission slot assignment (refer to 6.3.3.6.2 and to 6.4.4.2),*
- 3) *provide assignment of Reporting Rates to mobile station(s) (refer to 6.3.3.6.1. and to 6.4.3.1.4),*
- 4) *use of Channel Management Message*
- 5) *provide GNSS corrections via the VDL by Message 17 optionally*

### **7.7.7 (M.1371/A2-4.6) Repeater Operation**

*AIS base stations shall consider repeater operations where it is necessary to provide extended environments for shipborne AIS transponders. The extended AIS environment may contain one or more repeaters.*

*In order to implement this function efficiently and safely, the relevant authority shall perform a comprehensive analysis of the required coverage area and user traffic load, applying the relevant engineering standards and requirements.*

*A repeater may operate in the following modes:*

- 1) *Duplex repeater mode*
- 2) *Simplex repeater mode.*

#### **7.7.7.1 (M.1371/A2-4.6.1) Repeat Indicator**

*When shipborne equipment is transmitting a message, it shall always set the Repeat Indicator to Default = 0.*

#### **7.7.7.2 (M.1371/A2-4.6.1.2) Base station/repeater station use of Repeat Indicator**

The Repeat Indicator shall be transmitted by base / repeater stations whenever the transmitted message is a repeat of a message already transmitted from a station.

#### **7.7.7.3 (M.1371/A2-4.6.1.2.1) Number of Repeats**

'The number of repeats shall be a repeater station configurable function, implemented by the competent authority.

The number of repeats shall be set to either 1 or 2, indicating the number of further repeats required.

All repeaters within coverage of one another shall be set to the same number of repeats, in order to ensure that "Binary Acknowledgement" Messages No. 7 and "Safety Related Acknowledgement" Message No. 13 are delivered to the originating station.

Each time a received message is processed by the repeater station, the "Repeat Indicator" value shall be incremented by one (+1) before re-transmitting the message. If the processed "Repeat Indicator" equals 3, the relevant message shall not be re-transmitted.

#### **7.7.7.4 (M.1371/A2-4.6.2) Duplex Repeater Mode**

*This is a real time application – the same time slot is used for re-transmission on the paired frequency.*

*The received message requires no additional processing before being re-transmitted.*

*Repeat Indicator is not relevant when being used in duplex repeater mode.*

*A duplex channel is required, which comprises of a pair of frequencies, as described in ITU-R M.1084-3.*

#### **7.7.8 (M.1371/A2-4.7) Handling of Errors Related to Packet Sequencing and Groups of Packets**

*It shall be possible to group transmission packets, which are addressed to another station (refer to Addressed Binary and Addressed Safety Related Messages) based on sequence number. Addressed packets shall be assigned a sequence number by the transmitting station. The sequence number of a received packet shall be forwarded together with the packet to the Transport Layer. Also, when errors related to packet sequencing and groups of packets are detected (refer to 6.3.2.3), they shall be handled by the Transport Layer as described in 6.5.4.1.*

### **7.8 Transport layer**

The transport layer *shall* be responsible for:

- 1) converting data into transmission packets of correct size;
- 2) sequencing of data packets;
- 3) interfacing protocol to upper layers.

#### **7.8.1 (M.1371/A2-5.1) Definition of transmission packet**

A transmission packet *shall* be an internal representation of some information which can ultimately be communicated to external systems. The transmission packet *shall* be dimensioned so that it conforms to the rules of data transfer.

#### **7.8.2 (M.1371/A2-5.2) Source of a transmission packet**

The transport layer *shall handle* transmission packets from several sources:

- 1) position sensors, such as a GNSS;
- 2) from session layer;
- 3) from the network layer.

#### **7.8.3 (M.1371/A2-5.3) Conversion of data into transmission packets**

##### **7.8.3.1 (M.1371/A2-5.3.1) Presentation Interface**

The interface between the transport layer and above layers (i.e. the session layer) *shall* be called the Presentation Interface.

##### **7.8.3.2 (M.1371/A2-5.3.2) Conversion to transmission packets**

The transport layer *shall* convert data, received from the session layer, into transmission packets. If the resulting length of a transmission packet results in a data link message longer than five slots, the Presentation Interface message *shall* be divided into two or more transmission packets.

Taking into account that text and binary messages shall be used, it is of importance that the variable messages are set on byte boundaries. In order to ensure that the required bit stuffing for the variable length messages is provided for in the worst case condition, with reference to the packet format (ref. 6.3.2.2.2) the following parameters shall be used:

**Table 57**

<b>Number of slots</b>	<b>Maximum Data Bits</b>	<b>Stuffing Bits</b>	<b>Total Buffer Bits</b>
1	136	36	56
2	360	68	88
3	584	100	120
4	808	132	152
5	1032	164	184

When a mechanism is available that can pre-determine the required bit stuffing in order to optimise the message length, then it shall be done in accordance with r6.3.2.2.1.

### **7.8.3.3 (M.1371/A2-5.3.3) Conversion to presentation interface messages**

Each received transmission packet *shall have* a corresponding Presentation Interface message. The transport layer *shall* be responsible for converting between these formats and to sequence the messages correctly.

### **7.8.4 (M.1371/A2-5.4) Transmission packets**

#### **7.8.4.1 (M.1371/A2-5.4.1) Addressed mode**

In the addressed mode the data transfer packet *shall have* a destination user and *shall* expect an acknowledgement. *If an acknowledgement is not received the station shall retry the transmission. A timeout of 4 seconds shall be allowed before attempting retries. The number of retries shall be configurable between 0 and 3 retries. The default number of retries shall be 3 retries. The overall result of the data transfer shall be forwarded to above layers. The acknowledgement shall be between transport layers in two stations.*

*Each data transfer packet shall have a unique packet identifier consisting of the message type (binary vs. safety related messages), the source-ID, the destination-ID, and a sequence number.*

*The sequence number shall be assigned in the appropriate Presentation Interface message which is input to the station.*

*The destination station shall return the same sequence number in its acknowledgement message.*

*The source station shall not reuse a sequence number until it has been acknowledged or time-out has occurred.*

*These acknowledgements are applicable only to the VHF data link. Other means must be employed for acknowledging applications*

*Refer to the following figure X and to Annex F.*

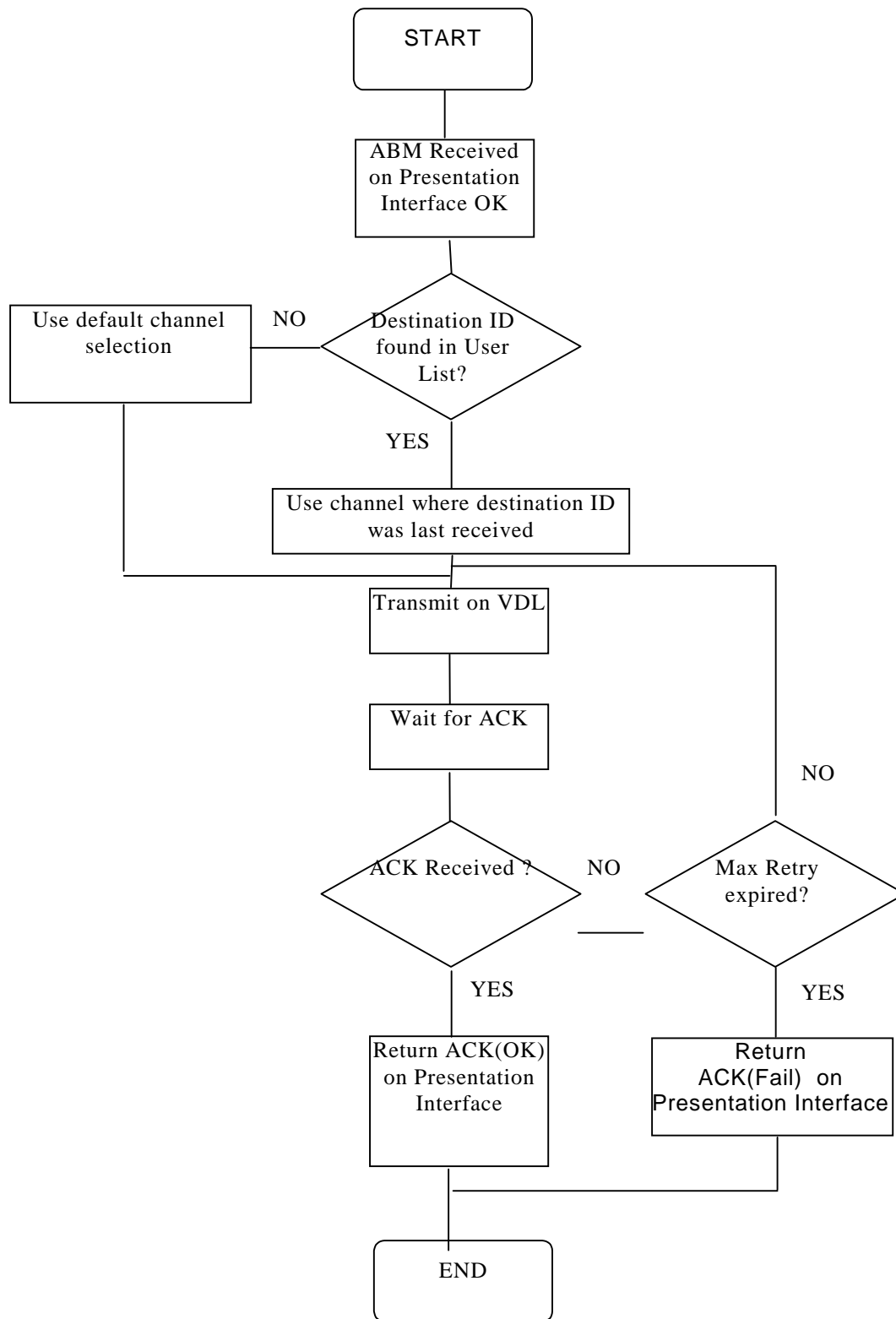


Figure 21

#### 7.8.4.1.1 (M.1371/A2-5.4.1.1) Broadcast

In the broadcast mode the packet lacks a destination identifier. Therefore receiving stations *shall* not acknowledge broadcast packets.

#### 7.8.4.1.2 (M.1371/A2-5.4.1.2) Sequencing for the Presentation Interface

Transmission packets received from the network layer *shall* be forwarded to the Presentation Interface in the order they were received regardless of message category. *Applications utilising the Presentation Interface shall be responsible for their own sequencing numbering scheme, as required.*

### 7.9 Presentation interface

#### 7.9.1 General[M.1371/A2-5.5]

*Data, which is to be transmitted (over the VDL) by the AIS device, shall be input via the Presentation interface. Data, which is received (from the VDL) by the AIS device, shall be output through the Presentation layer Interface. The formats and protocol used for this data stream are defined by the referenced IEC 61662 series.*

If no appropriate IEC 61162 format and protocol exist, other protocols may be used.

##### 7.9.1.1 User Interface [A3/4]

*To enable a user to access, select, and display the information on a separate system, the AIS shall be provided with an interface conforming to an appropriate international marine interface standard.*

##### 7.9.1.2 Long Range Applications [M.1371/A4]

*The AIS transponder shall provide a two-way interface for equipment which provides for long range communications. The interface shall comply with the IEC 61162 series.*

##### 7.9.1.3 Composition [M.1371, A2-5.5]

The Presentation layer interface of the AIS shall be comprised of the data ports listed in Table 37. (Also see Annex I, "Presentation Interface overview")

**Table 58**

General Function	Mechanism
Automatic Input of Sensor Data (Sensor data input from shipboard equipment)	(3) IEC 61162-2 input ports, also configurable as IEC 61162-1 input ports
High Speed Input / Output Ports (Operator controlled commands and data input; AIS VHF Data Link (VDL) data; and AIS equipment status)	(2) IEC 61162-2 paired input and output ports
Long Range Communications	(1) IEC 61162-2 paired input and output ports
DGNSS Correction Data	(1) IEC 61108-4 input port (optional - output AIS VDL DGNSS data)
BITT Alarm Output	(1) Isolated normally-open normally-closed (NONC) contact circuit

#### 7.9.2 Automatic Input of Sensor Data

##### 7.9.2.1 Required Ports

A minimum of three input ports shall be provided. Each port shall meet the requirements of IEC 61162-2 and be capable of being reconfigured to IEC 61162-1.

### 7.9.2.2 Interface Connector

The connector for these ports shall be specified by the manufacturer.

### 7.9.2.3 Format of Sensor Data

The sensor data shall be provided using the formats described in IEC 61162-1. As a minimum, the preferred IEC 61162-1 sentences listed in Table 38 (Preferred IEC 61162-1 Sentences) shall be received and processed by an AIS unit. Details for these sentences are contained in IEC 61162-1.

**Table 59**

Data	IEC 61162-1 Sentences
Positioning system: Time of position Latitude / Longitude Accuracy [and integrity status]	<u>GNS and DTM</u> , [RMC and DTM]
Speed Over Ground (SOG)	<u>VBW</u> , [VTG]
Course Over Ground (COG)	<u>RMC</u> , [VTG]
Heading	HDT
Rate Of Turn (ROT)	ROT
Route Plan	<u>RTE</u> , [WPL]

Manufacturers may implement additional IEC 61162-1 sentences.

Each of the data items listed in Table 38 (Preferred IEC 61162-1 Sentences) may be produced by various connected sensor equipment. The external sensor equipment is neither assigned to specific AIS input ports nor are the specified input sentences assigned to specific equipment. An AIS shall be capable of accepting these specified sentences at each of the input ports.

## 7.9.3 High Speed Input / Output Ports

### 7.9.3.1 Required Ports

A minimum of two pairings of an input and output port shall be provided. A primary input/output port for connection of onboard control equipment, ECDIS, radar, etc., and an auxiliary input/output port for connection of ship's pilot portable equipment, service equipment, etc. Each port shall meet the requirements of IEC 61162-2.

Both input ports shall be functionally equivalent and shall be capable of receiving the data formats defined in Table 40 (AIS High-speed Input Data and Formats).

Both output ports shall be functionally equivalent and shall be capable of simultaneously transmitting the data formats defined in Table 41 (AIS High-speed Output Data and Formats).

### 7.9.3.2 Interface Connector

The connector for these ports shall be specified by the manufacturer.

### 7.9.3.3 Input Data and Formats

The input data shown in Table 40, at a minimum, shall be received and processed by an AIS. Manufacturer's proprietary data may also be entered using the high-speed ports. Except for the manufacturer's proprietary data, details of these sentences are contained in IEC 61162-1.

**Table 60**

<b>Data</b>	<b>IEC 61162-1 Sentences</b>
<b>Normal Access - Parameter Entry</b>	
Voyage Information: Vessel type and cargo category Navigational status Draught, max. actual static Destination ETA date and time Regional Application Flags	VSD - voyage static data
Static Station Information Vessel name Call sign Antenna location length and beam	SSD - Station static data
<b>Initiate VHF Data-link Broadcasts</b>	
Safety messages	ABM - Addressed Binary Message BBM - Broadcast Binary Message
Binary Messages	ABM - Addressed Binary Message BBM - Broadcast Binary Message
Interrogation Message	AIR - AIS Interrogation Information
<b>Limited Access - Parameter Entry</b>	
MMSI IMO number AIS VHF channel selection VHF power setting Other AIS equipment controls	Integral Display or proprietary sentences  [A security mechanism to access and change these information shall be provided]
<b>BIIT Input</b>	
Alarm /indication acknowledgement	ACK Acknowledgement message

**7.9.3.4 Output Data and Formats**

The output data shown in Table 41, at a minimum, shall be produced and sent by an AIS. The VDM sentence is sent simultaneously on all the high-speed output ports for every VHF Data-link message received. (Note that a few VDL messages are informative, and that, during operation, their delivery may be disabled by the operator.) Manufacturer's proprietary data may also be sent using the high-speed ports. Except for the manufacturer's proprietary data, details of these sentences are contained in IEC 61162-1.

**Table 61**

<b>Data</b>	<b>IEC 61162-1 Sentences</b>
<b>Prepared by AIS Unit</b>	
Notification that a session initiated by messages ABM, BBM, ACA, AIR is terminated	ABK - Acknowledgement Message <sup>4</sup>
AIS Own-ship Broadcast Data (all transmissions available)	VDO - VHF Data-link Own-vessel message <sup>5</sup>

<sup>4</sup> see ITU-R M.1371 (2000), sections 5.4.1 and 3.3.8.2.5.

<sup>5</sup> The VDO output for all broadcast VDL messages are for information purposes only. Their VDO coded output is required, but during operation, it may be suppressed by the AIS configuration.

[AIS equipment status (Built-in-integrity-test results)]	[ALR,TXT - internal AIS unit Integrity Test Result] <sup>6</sup>
<b>Received on VHF Data-link by AIS Unit</b>	
All VDL AIS messages received Broadcast or Addressed to own Station	VDM - VHF Data link Message <sup>7</sup>

#### 7.9.4 Data Network Connection

[The provision of a high speed network connection (NMEA2000 / IEC 61162-3) is optional. It will become a requirement in a later revision of this standard, when the relevant standard (IEC 61162-3) is completed and adopted.]

#### 7.9.5 Long Range Communications

##### 7.9.5.1 Required Ports

A minimum of one pairing of an input and output port shall be provided. The input/output port is connected to long-range communications equipment (e.g., satellite communications; see section 8). Each of these ports shall meet the requirements of IEC 61162-2.

The input port shall be capable of receiving the data formats defined in Table 42 (AIS Long range Communications Input Data and Formats).

The output port shall be capable of transmitting the data formats defined in Table 43 (AIS Long range Communications Output Data and Formats).

##### 7.9.5.2 Interface Connector

The connector for these ports shall be specified by the manufacturer.

##### 7.9.5.3 Input Data and Formats

Long Range interrogation of an AIS unit is accomplished through the use of two IEC 61162-1 sentences - LRI and LRF. This pair of interrogation sentences provides the information needed by the AIS unit to determine if it must construct and provide the reply sentences - LR1, LR2, and LR3. The LRI-sentence contains the information needed to determine if the reply needs to be constructed. The LRF-sentence identifies the information that is being requested.

The information, that can be requested by the LRF-sentence, is shown in Table 42 (AIS Long Range Communications Input Data and Formats). These information items are the same as those defined in IMO Resolution A.851(20). The letters shown in parentheses are from IMO Resolution A.851(20) and are used in the LRF-sentence. Details of these sentences are contained in IEC 61162-1.

**Table 62**

**AIS Long range Communications Input Data and Formats**

<b>Data</b>	<b>IEC 61162-1 Sentences</b>
Long Range Interrogation Type of request Geographic area request AIS unit request	LRI - Long Range Interrogation

<sup>6</sup> The AIS unit should provide "AIS equipment status" information using a "proprietary IEC 61162-1 sentence" developed by the manufacturer.

<sup>7</sup> The VDM output for received VDL messages 7, 10, 11, 13, 15, 16, 17, 20, and 22 are for information purposes only. Their VDM coded output is required, but during operation, it may be suppressed by the AIS configuration.

Long Range Function identification Requestor MMSI and Name Request for: Ship's name, call sign, and IMO number (A) Date and time of message composition (B) Position (C) Course over ground (E) Speed over ground (F) Destination and ETA (I) Draught (O) Ship / Cargo (P) Ship's length, breadth, and type (U) number of persons on board (W)	LRF - Long Range Function Identification
--	--

#### 7.9.5.4 Output Data and Formats

The Long Range reply of the AIS unit is accomplished through the use of three IEC 61162-1 sentence formatters - LR1, LR2, and LR3. The AIS unit shall reply with the three sentences, in the order LR1, LR2, and LR3, when responding to an interrogation - even if all the information items in the sentence are null. The LR1-sentence identifies the destination for the reply and contains the information items requested by the "A" function identification character in the LRF-sentence. The LR2-sentence contains the information items requested by the "B, C, E, and F" function identification characters in the LRF-sentence. The LR3-sentence contains the information items requested by the "I, O, P, U and W" function identification characters in the LRF-sentence.

The individual information items will be null if any of the following conditions exist:

- The information item was not requested in the LRF-sentence,
- The information item was requested but is not available, or
- The information item was requested but is not being provided.

The output data shown in Table 43 shall be provided when specifically requested by function identification characters contained in the preceding LRF-sentence portion of the interrogation. Details of these sentences are contained in Chapter 8 and IEC 61162-1.

**Table 63**

**LR Output Data Formats**

Data	IEC 61162-1 Sentences
MMSI of Responder MMSI or Requestor Ship's Name Ship's call sign IMO Number	LR1 - Long Range Response, line 1
MMSI of Responder Date and time of message composition Position Course over ground Speed over ground	LR2 - Long Range Response, line 2

MMSI of Responder	LR3 - Long Range Response, line 3
Destination and ETA	
Draught	
Ship / Cargo	
Ship's length, breadth, and type	
number of persons on board	

### 7.9.6 DGNSS Correction Data

#### 7.9.6.1 Input Port

[An input port may be provided to interface the AIS unit with the shipboard equipment that provides DGNSS corrections (e.g., DGNSS radio-beacon receiver). The input port and data format shall meet the requirements of ITU-R M.823-3.

This input port shall be provided if the internal GNSS receiver is used as a backup device for position reports.]

#### 7.9.6.2 Optional Output Port

The AIS unit shall be capable of receiving DGNSS data on the VDL (refer to 6.3.3.8.2.13, DGNSS Broadcast Binary Message).

An optional output port may be provided to supply shipboard equipment (e.g., GNSS receivers) with DGNSS corrections provided via the VHF Data Link. The DGNSS corrections (Message 17) shall then be converted into the format that conforms to ITU-R M.823-3, including parity formatting.

#### 7.9.6.3 Interface Connector

The connector for this port shall be specified by the manufacturer.

### 7.9.7 BIIT Alarm Output

The AIS shall provide a 3-terminal changeover relay output (NONC contact) indicating the state of the Built-In Integrity Test (BIIT) alarm function.

Relay terminals A, B, and C shall be configured as common terminal C having a normally-open (no alarm) connection to terminal (A) and a normally-closed (no alarm) connection to terminal (B).

The terminals shall be isolated from circuits and grounds in the AIS.

The AIS manufacturer's documentation shall specify the current and voltage capacity of the alarm relay.

## 8 DSC compatibility

### 8.1 (/A3-2.1) General

#### 8.1.1 Capabilities

*The AIS shall be capable of performing limited AIS-related DSC operations conforming to the provisions of Recommendation ITU-R M.493, M.541 and M.825-3. These operations shall not include either Annex 2 of Recommendation ITU-R M.825-3 or distress-related features of Recommendation ITU-R M.493. In order to accomplish this performance, the AIS device shall contain a dedicated DSC receiver that is tuned to channel 70. However, a dedicated DSC transmitter is not required.*

#### 8.1.2 Shore stations operation

*DSC-equipped shore stations may transmit DSC all-ships calls on channel 70 to specify regional boundaries and regional frequency channels to be used by the AIS in those specified regions.. The*

*AIS device shall be capable of responding to Expansion Symbols No. 09, 10, 11, 12, and 13 of Table 5 of Recommendation ITU-R M.825-3 by performing operations in accordance with paragraphs 6.4.1.1 to 6.4.1.5 with the regional frequencies and regional boundaries specified by these calls.*

## **8.2 (A3-2.2) Scheduling**

### **8.2.1 Restrictions**

*DSC operations performed by the AIS shall be scheduled subject to the TDMA operations such that the TDMA operations are not impaired or delayed.*

### **8.2.2 Transmission delay**

*The automatic response to DSC calls addressed to a "VTS area" shall be transmitted after a random delay distributed over the range of 0 to 20 s providing the DSC signalling channel is clear of other traffic and subject to the restrictions of 7.2.1.*

## **8.3 Polling**

### **8.3.1 Capabilities for polling**

*The AIS shall be capable of automatically transmitting a DSC response to an interrogation request for information as specified in Recommendation ITU-R M.825-3 Annex 1. An automatic response shall be transmitted to any interrogation containing one or more of the symbols 101, 102, 103, 104, 108, 109, 111, 112 and 116 of table 4 of Annex 1 of Recommendation ITU-R M.825-3. When an automatic response is required but the requested information is not available, in the response the relevant symbol shall be followed by the symbol 126.*

### **8.3.2 Response to polling**

*Transmitted responses shall be made on channel 70 unless instructed otherwise by symbol number 101. However the AIS shall be inhibited from transmitting DSC responses on TDMA channels AIS 1 and AIS 2. If and when frequency channels other than channel 70 are used for DSC transmissions, the receive capability of TDMA operations shall not be impaired more than it would be, if all DSC messages were transmitted on channel 70.*

### **8.3.3 Limitations on polling**

*The AIS shall not transmit DSC interrogation messages which request information.*

## **8.4 Regional channel designation**

*For designation of regional AIS frequency channels, expansion symbols No. 09, 10 and 11 shall be used in accordance with Table 5 of Recommendation ITU-R M.825-3. Each of these expansion symbols shall be followed by two DSC symbols (4 digits) which specify the AIS regional channel(s), as defined by Recommendation ITU-R M.1084-2, Annex 3. This allows for simplex, duplex, 25 kHz and 12.5 kHz channels for regional options, subject to the provisions of Appendix S18 of the Radio Regulations. Expansion symbol No. 09 shall designate the primary regional channel, and expansion symbol No. 10 or 11 shall be used to designate the secondary regional channel.*

*When single-channel operation is required, then only expansion symbol No. 09 shall be used. For two-channel operation, either expansion symbol No. 10 shall be used to indicate that the secondary channel is to operate in both transmit and receive modes, or expansion symbol No. 11 shall be used to indicate that the secondary channel is to operate only in receive mode.*

## **8.5 Regional area designation**

*For designation of regional areas for utilising AIS frequency channels, expansion symbols No. 12 and 13 shall be in accordance with Table 5 of Recommendation ITU-R M.825-3. Expansion symbol No. 12 shall be followed by the geographical coordinate address of the north-eastern corner of the Mercator projection rectangle to the nearest tenth of a minute. Expansion symbol No. 13 shall be followed by the geographical coordinate address of the south-western corner of the Mercator projection rectangle to the nearest tenth of a minute.*

## 9 Long range applications

(M.1371/A4) *The AIS transponder shall provide a two-way interface for equipment which provides for long range communications. This interface shall comply with IEC 61162.*

### 9.1 (M.1371/A4) General

*The AIS transponder shall provide a two-way interface for equipment which provides for long range communications. This interface shall comply with IEC 61162.*

Long Range (LR) communications shall be only through the Presentation layer using the IEC 61162-2 interface dedicated to this purpose as described in Ch. 7.9.5.

Long Range applications shall be LR responses to LR interrogations from LR base stations.

The LR AIS data shall be displayed on the AIS display as described in **Error! Reference source not found.**

### 9.2 Interrogations and responses

LR responses shall only be transmitted in response to an interrogation.

#### 9.2.1 Manual and automatic response

The AIS transponder shall be capable of being set by the user to respond automatically or manually to LR interrogations. In case of automatic reply to LR interrogations, the display shall indicate that the system was LR interrogated until cancelled by the operator. In case of manual reply to LR interrogation, the display shall indicate that the system was LR interrogated until the operator will reply the message or cancel the reply on the manual input device as described in 5.12.1

#### 9.2.2 Data formats and contents

The LR messages shall be based on the IMO Resolution A.851(20), 'General principles for ship reporting systems and ship reporting requirements, including guidelines for reporting incidents involving dangerous goods, harmful substances and/or marine pollutants' as far as the AIS system has the information available.

The LR functions available to the AIS shall be as described in the table 46, including the function format. The available information shall be derived from the AIS system. If a function identifier has the indication 'not available', the information is not available in the standard AIS system at this moment. (It could be possible to gather this type of information from a different source, outside the AIS system).

If any function which is 'not available' is asked by a LR interrogation, the reply shall give a "blank information [null] field.

**Table 64**

ID	Function Format	Remarks
A	Ship name / Call sign / MMSI / IMO number	MMSI number shall be used as a flag identifier
B	Date and time in UTC	time of composition of message shall be given in UTC only. Day of month , hours and minutes
C	Position	WGS84; Latitude / Longitude degrees and minutes
D		not available

E	Course	Course over ground (COG) in degrees
F	Speed	Speed over ground (SOG) in knots and 1/10 knots
G, H		not available
I	Destination / ETA	at masters discretion; ETA time format see B
J, K, L, M, N		not available
O	Draught	actual maximum draught in 1/10 of meters
P	Ship / Cargo	see table 18
Q, R, S, T		not available
U	Length / Beam / Type	length and beam in meters type see table 18, tonnage not available
V		not available
W	Number of persons on board	
X,Y		not available
Z		not used

### 9.2.3 Addressing AIS-units

LR interrogations shall be either by user ID (ship's MMSI) or by geographical area "All ships" call designating the north-eastern corner and the south-western corner of the Mercator projection rectangle which describes the called area.

The first LR data transfer shall take place by LR interrogation initiated by a geographical area "All ships" call to the long-range communication system.

Succeeding LR data transfers shall take place by LR interrogation based on user ID (MMSI)

To avoid replies on succeeding geographical area "All ships" calls from the same base station, the internal AIS user directory shall store the MMSI of the LR base station for 24 hours.

## 10 Test conditions

### 10.1 General

The manufacturer shall declare the composition of the equipment and the relevant category of IEC 60945 for each unit. AIS equipment declared for protected installation shall meet the requirements described in Table 3 Column "Protected" of IEC 60945. Exposed AIS equipment shall meet the requirements described in Table 3 Column "Exposed" of IEC 60945. Carry-aboard AIS equipment shall meet the requirements of Table 3 "protected" or "exposed" as appropriate.

In case of differences between this standard and corresponding clauses of IEC 60945, this standard shall have precedence.

### 10.2 Normal and extreme test conditions

#### 10.2.1 Normal test conditions

##### 10.2.1.1 Temperature and humidity

Temperature and humidity shall be within following range:

Temperature	+15° to +35° C
Humidity	20% to 75%

##### 10.2.1.2 Power supply

The normal power supply for the tests shall be in accordance with IEC 60945 Cl 5.2.1.

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of this standard, the nominal voltage shall be the declared voltage or any of the declared voltages for which the equipment was designed.

The frequency of the test power source corresponding to the ac mains shall be between 49 Hz and 61 Hz.

For the purpose of tests, the voltage of the power source shall be at the input terminals of the equipment.

If the equipment is provided with a permanently connected power cable, the test voltage shall be that measured at the point of connection of the power cable to the equipment.

##### 10.2.2 Extreme test conditions

Extreme test conditions are as specified in IEC 60945. Where required, test under extreme test conditions shall be a combination of dry heat and upper limit of supply voltage applied simultaneously and low temperature and lower limit of supply voltage applied simultaneously.

During type testing the power source to the equipment may be replaced by a test power source, capable of producing normal and extreme test voltages.

### 10.3 Standard Test environment

[The EUT is tested in an environment including mobile, base and repeater stations and a test equipment to log VDL-messages (see Annex J and Annex K). Additional targets may be simulated, where required. Additional AIS Targets needed for specific tests are included using a simulation. Own ship sensor inputs to EUT may be simulated or from real ship. Operation is checked on channels in the maritime mobile band.]

[Channels in use shall be selected by manual input or channel assignment messages before starting tests.]

## **10.4 Test Signals**

### **10.4.1 Standard Test Signal Number 1**

A DSC call with an individual station address and with command sets 103 (report your position) and 111 (report ship name) unless otherwise stated.

### **10.4.2 Standard Test Signal Number 2**

For TDMA Type 1: A test signal consisting of an infinite series of 010101

### **10.4.3 Standard Test Signal Number 3**

For TDMA Type 2: A test signal consisting of an infinite series of 00110011.

NOTE : Transmitters may have limitations concerning their maximum continuous transmit time and/or their transmission duty cycle. It is intended that such limitations are respected during testing.

## **10.5 Test conditions for the transmitter and TDMA receivers**

All measurements of 15.1 and 15.3 shall be performed on at least two channels (high and low) within the frequency range 156.025 MHz to 162.025 MHz, utilising channels according to [Appendix 18 of ITU Radio Regulations], except where stated otherwise.

## **10.6 Arrangements for test signals applied to the receiver input**

Sources of test signals for application to the receiver input shall be connected in such a way that the source impedance presented to the receiver input is 50  $\Omega$  (See 10.10).

This requirement shall be met irrespective of whether one or more signals using a combining network are applied to the receiver simultaneously.

The levels of the test signals at the receiver input terminals (RF socket) shall be expressed in terms of dBm.

The effects of any intermodulation products and noise produced in the test signal sources shall be negligible.

## **10.7 Encoder for receiver measurements**

Whenever needed and in order to facilitate measurements on the receiver, an encoder for the data system shall accompany the EUT, together with details of the normal modulation process. The encoder is used to modulate a signal generator for use as a test signal source.

Complete details of all codes and code format(s) used shall be given.

## **10.8 Waiver for receivers**

If the manufacturer declares that both TDMA receivers are identical, the test shall be limited to one receiver and the test for the second receiver shall be waived. The test report shall mention this.

## **10.9 Transceiver data interface**

[Equipment that does not integrate a keyboard and display used for normal operation shall provide a V.24/V.28 interface (preferably) or other suitable interfaces.](Move to requirements)

In the case where the equipment uses a proprietary interface, appropriate means and documentation allowing for the equipment to be tested shall be provided in view of type testing.

Variation in the level of the input signals, within the specified limits for that interface, shall have [non-measurable] influence on the characteristics of the signals on the radio path.

## 10.10 Impedance

In this standard the term "50  $\Omega$ " is used for a 50  $\Omega$  non-reactive impedance.

## 10.11 Artificial antenna (dummy load)

Tests shall be carried out using an artificial antenna which shall be a non-reactive non-radiating load of 50  $\Omega$  connected to the antenna connector.

NOTE: Some of the methods of measurement described in this standard for the transmitters, allow for two or more different test set ups in order to perform those measurements. The corresponding figures illustrate therefore one particular test set up, and are given as examples. In many of those figures, power attenuators (providing a non-reactive non-radiating load of 50  $\Omega$  to the antenna connector) have been shown. These attenuators are not "artificial antennas" as defined in 10.11. The method of measurement used shall be stated in the test report.

## 10.12 Facilities for access

### 10.12.1 Test points for bit stream measurements

It is recognised that it is not always possible to measure the air interface bit stream. The manufacturer may define the test points at which the equipment shall be tested in order to make the measurements on bit streams.

The following figure is presented as an example for clarification only.

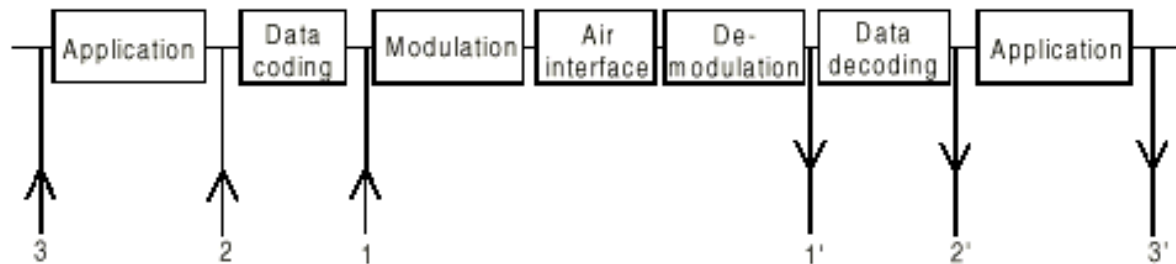


Figure 22

It should be noted that the closer the test access point is located to the air interface (Figure 22), [a smaller number of variants] may have to be type tested because the measurement is less application dependent.

Each test shall be performed by the use of a corresponding pair of test points (See Figure 22: 1 and 1' or 2 and 2' or 3 and 3').

The test points used shall be recorded in the test report.

### 10.12.2 Arrangements for measurements with messages

For the measurement of the receiver on a test site, arrangements to couple the EUT to the test device shall be available.

## 10.13 Modes of operation of the transmitter

For the purpose of the measurements according to this standard, there shall be a facility to operate the transmitter unmodulated.

Alternatively, the method of obtaining an unmodulated carrier or special types of modulation patterns may also be decided by agreement between the manufacturer and the test laboratory. It shall be described in the test report. It may involve suitable temporary internal modifications of the equipment

under test. For instance in the case of direct Frequency Shift Keying (FSK), a means to continuously transmit a sequence D-M0 containing only "zeros" and a sequence D-M1 containing only "ones" is preferable.

#### **10.14 Measurement uncertainties**

TBD

### **11 Power supply, special purpose and safety tests**

Tests for power supplies, special purposes and safety shall be performed as specified in IEC 60945 clauses 7, 11 and 12. Waivers as indicated in IEC60945 shall apply.

### **12 Environmental tests**

Environmental tests shall be performed as specified in IEC 60945 clause 8.

The Performance Test to be used for the environmental tests is for the transmitter:

- frequency error (see\*\*\* )
- carrier power (see \*\*\*)
- channel switching (see \*\*\*)
- transmitter attack time (see \*\*\*)
- transmitter release time (see \*\*\*);

and for the receiver (both TDMA and DSC):

- sensitivity at 25 kHz and 12.5 kHz(see \*\*\*),
- channel switching time (see \*\*\*).

For the Performance Check to be used with the environmental tests, the EUT shall be set into autonomous mode using channels AIS1 and AIS2 with a reporting interval of 3 s in the standard test environment (10.3).

### **13 E M C tests**

Tests for EMC conducted emissions shall be performed as specified in IEC 60945 Cl. 9. The tests for radiated emissions are covered by 15.3.15.

Tests for EMC immunity shall be performed as specified in IEC 60945 Cl. 10.

To demonstrate compliance with the performance criteria for the EMC immunity tests, the EUT shall be set into autonomous mode using channels AIS1 and AIS2 with a reporting interval of 2 s in the standard test environment (10.3). The contents of the reports and the reporting intervals shall not be degraded during or after the test, as appropriate for the considered criterion.

Performance Criterion C shall be taken to mean that the functions of the EUT are self-recoverable i.e. without operation of controls.

## **14 Operational tests**

### **14.1 (4.2) Operating modes / Capability**

#### **14.1.1 Autonomous mode**

##### **14.1.1.1 Transmit Position reports**

###### **Method of measurement:**

Set up a test environment of at least 5 test targets.

- a) Start operation of the EUT outside Range of test environment and let the EUT enter range
- b) Start operation of the EUT inside range of test environment

Record the VDL communication and check for messages of the EUT.

###### **Required results:**

Confirm that EUT transmits continuously under conditions a) and b) and that transmitted data complies with sensor inputs.

##### **14.1.1.2 Receive Position reports**

###### **Method of measurement:**

Set up a test environment of at least 5 test targets.

- a) Start operation of the EUT outside range of test environment and let the EUT enter range
- b) Start operation of the EUT inside range of test environment

Check the VDL communication and high speed I/O port outputs of the EUT.

###### **Required results:**

Confirm that EUT receives continuously under conditions a) and b) and outputs the received messages via the PI.

#### **14.1.2 Assigned mode**

###### **Method of measurement:**

Operate standard test environment and EUT in autonomous mode. Transmit an Assigned mode command message msg16 to the EUT with:

- a) Slot offset and increment
- b) Designated reporting rate.

Record transmitted messages.

###### **Required results:**

Confirm that the EUT transmits position reports message msg2 according to defined parameters and reverts to SOTDMA msg1 with standard reporting rate after 4 to 8 min.

### 14.1.3 Polled mode

#### 14.1.3.1 Transmit an interrogation

##### Method of measurement:

Operate standard test environment and EUT in autonomous mode. Initiate the transmission of interrogation message msg15 (EUT as source) addressing 1 or 2 destinations according to message table \*\*\*6.3.3.8.1 by the EUT for responses with

- mobile station msg1, msg5[TBD]
- base station msg4, msg17, msg20, msg22. [TBD]

Record transmitted messages.

##### Required results:

Check that EUT transmits the interrogation message msg15 as appropriate.

#### 14.1.3.2 Interrogation response

##### Method of measurement:

Operate standard test environment and EUT in autonomous mode. Apply an interrogation message15 (EUT as destination) to the VDL according to message table \*\*\*6.3.3.8.1 for responses with msg1, msg5 and slot offset set to defined value. Record transmitted messages and frame structure.

##### Required results:

Check that the EUT transmits the appropriate interrogation response message as requested after defined slot offset. Confirm that the EUT transmits the response on the same channel as where interrogation was received.

### 14.1.4 Addressed operation

#### 14.1.4.1 Transmit an addressed message

##### Method of measurement:

Operate standard test environment and EUT in autonomous mode. Initiate the transmission of an addressed binary message msg6 (with EUT as source) according to message table \*\*\*6.3.3.8.1 by the EUT. Record the transmitted messages.

##### Required results:

Check that the EUT transmits the message msg 6 as appropriate. Repeat test with the addressed safety related message msg12.

#### 14.1.4.2 Receive an addressed message

##### Method of measurement:

Operate standard test environment and EUT in autonomous mode. Apply an addressed binary message msg6 (EUT as destination) to the VDL according to message table \*\*\*6.3.3.8.1. Record transmitted messages and frame structure.

##### Required results:

Check that EUT transmits the appropriate acknowledgement message. Confirm that EUT outputs the received message via the high speed I/O port.

## **14.2 (\*\*4.2) Multiple slot messages**

### **14.2.1 5 slot messages**

#### **Method of measurement:**

Apply a msg8 (binary message) to the PI of EUT with a max. of 124 data bytes of binary data.

#### **Required results:**

Check that the message is transmitted in up to 5 slots accordingly.

### **14.2.2 Longer messages**

#### **Method of measurement:**

Apply a msg8 (binary message) to the high speed I/O port of EUT with more than 124 data bytes of binary data.

#### **Required results:**

Check that the message is divided into two or more messages 8 (\*\*6.5.3.2 page 84). Check that each VDL transmission does not exceed 5 slots.

## **14.3 (\*\*5.4) Information content**

#### **Method of measurement:**

Operate standard test environment and EUT in autonomous mode.

- a) Apply all static, dynamic and voyage related data to the EUT
- b) Simulate unavailable or invalid input data.
- c) Apply a non WGS84 or unspecified position input
- d) Apply a low accuracy position input (e. g. GNSS uncorrected)

Record all messages on VDL and check the contents of position report message msg1 and static data report message msg5.

#### **Required results:**

- a) Confirm that data transmitted by the EUT complies with manual and sensor inputs.
- b) Confirm that data which is not available or invalid is set accordingly.
- c) Confirm that only WGS84 data is used for transmission.
- d) Confirm that accuracy field is set accordingly.

## **14.4 (\*\* 5.4.2, 6.4.3 ) Reporting rates**

### **14.4.1 Speed and course change**

#### **Method of measurement:**

Operate standard test environment and EUT in autonomous mode.

- a) start with own speed of 10kn; record all messages on VDL for 1h and evaluate reporting rate for position report of EUT by calculating average slot offset over test period.
- b) Increase speed and change course (rot > 20°/min) to cover 5.4.2 table 1.
- c) Reduce speed and rotation rate below given steps.
- d) Make speed and/or heading sensor unavailable.

For b), c), d) record all messages on VDL and check slot offset between two consecutive transmissions.

**Required results:**

- a) Reporting rate shall comply to \*\*\*5.4.2 table 1 12sec  $\pm 10\%$ .
- b) Confirm that the new reporting rate has been established after 2 transmissions  $\pm 20\%$ .
- c) Confirm that the reporting rate is reduced after 4min (speed reduction) or 20sec (ROT reduction).
- d) Check that with unavailable sensors the reporting rate reverts to default values (12sec if no sensor connected).

**14.4.2 Change of navigational status****Method of measurement:**

Operate standard test environment and EUT in autonomous mode. Change Navigational status by applying voyage data message to the high speed I/O port of EUT.

- a) set NavStatus to "at anchor"
- b) set NavStatus to other values

Record all messages on VDL and evaluate reporting rate of position report of EUT.

**Required results:**

- a) Reporting rate shall be 3min.
- b) Reporting rate shall be adjusted according to speed and course (see 14.4.1)

**14.4.3 Assigned reporting rates****Method of measurement:**

Operate standard test environment and EUT in autonomous mode. Transmit an Assigned mode command message msg16 to the EUT with:

- a) initial slot offset and increment.
- b) designated reporting rate.

Change course, speed and NavStatus. Record transmitted messages.

**Required results:**

Confirm that the EUT transmits position reports message msg2 according to the defined parameters (See \*\*\*) and reverts to msg1 in autonomous mode with standard reporting rate after 4 to 8 min. The reporting rate shall not be affected by course, speed and NavStatus.

**14.4.4 Static data reporting rates****Method of measurement:**

Operate standard test environment and EUT in autonomous mode. Record the transmitted messages and check for static and voyage related data (msg5).

**Required results:**

Confirm that the EUT transmits msg5 with a reporting rate of 6min.

**14.5 (5.5) Security****Method of measurement:**

Operate standard test environment and EUT in autonomous mode. Switch the EUT off and on. [Simulate errors which are to be recorded] according to manufacturers documentation. Recover and readout recorded data.

**Required results:**

Confirm that the EUT records and displays events correctly.

**14.6 (5.6) Initialisation period****Method of measurement:**

Operate standard test environment with all sensors available. Switch on EUT with EUT operating in autonomous mode; switch off EUT for ~0.5sec. Record transmitted messages.

**Required results:**

Confirm that the EUT is operational at least 2min after switching on and that [short] power loss does not cause blocking or undefined states of the system.

**14.7 Frequency range and Channel spacing****Method of measurement**

Operate standard test environment and EUT in autonomous mode. Switch the EUT to [X channels] of the maritime mobile band as specified by ITU-R M.1084-3, Annex 4 using 25kHz and 12.5kHz channel spacing manually and by transmission of channel management message msg20. Record the VDL messages.

**Required results:**

Confirm that the EUT switches to Channel / bandwidth and Duplex / simplex mode accordingly.

**14.8 (\*\*5.8) Range performance****Method of measurement:**

Operate standard test environment and EUT in autonomous mode. Change the distance from the EUT to other mobile / base / repeater stations from 0,1nm to 30nm. Record the VDL messages and high speed I/O port. Compare with nominal transmissions according to the reporting rate.

**Required results:**

Distances where >10%, >50% and >90% of messages are lost are noted. At [close ranges] there shall be no gaps in coverage. VHF visibility range shall be covered with <10% messages lost under average sea and weather conditions.

**14.9 (\*\*5.8, 6.2.15) Safety precautions****Method of measurement**

Operate standard test environment and EUT in autonomous mode. Open circuit and short circuit antenna terminals of the EUT for at least 60 s.

**Required results:**

The EUT shall continue normal operation after refitting the antenna without damage to the transmitter.

**14.10 (\*\*5.8) Interference immunity****Method of measurement**

Set up standard test environment and operate EUT in autonomous mode. Record received messages. Transmit with VHF Radiotelephone (GMDSS) [25W, distance 20m] on adjacent channel.

Repeat the test using other channel combinations within the maritime mobile band.

Record received messages.

**Required results:**

Message loss shall not occur.

**14.11 (\*\*5.10) Alarms and indicators, fall-back arrangements**

**14.11.1 General**

[All tests shall be done only by accessing external or internal parts of the system which are easy to reach. Where it is not possible to create a test condition without destroying parts or without affecting other functions not to be tested simultaneously the manufacturer shall prove the functionality by corresponding documentation.

It shall be verified that for all failure modes, correct alarm numbers and information for the user are output on the serial interfaces and acknowledgements are accepted.

User information provided for the corresponding condition shall be checked against the manufacturers documentation.

Normative details are specified in Annex B.]

**14.11.2 Data availability, loss of data**

**Method of measurement**

Disconnect the inputs for heading, speed over ground, course over ground, and rate of turn or set their data invalid (e.g. by wrong checksum, "valid/invalid" flag).

This shall be done one after the other and simultaneously.

**Required Result**

Verify that the system continues to operate but without using the affected data.

Verify that the relay output indicates the failure state.

**14.11.3 Monitoring of functions and integrity**

**14.11.3.1 Loss of UTC and position**

**Method of measurement**

Operate the standard test environment and EUT in autonomous mode.

- a) Disconnect the GNSS antenna (UTC clock lost).
- b) Disconnect the position input.

**Required result**

- a) Verify that the system continues to operate but converts to indirect synchronisation.

Verify that the relay output signals the failure state.

- b) [Verify that the EUT ceases transmission when not automatically using the position derived from the internal GNSS module]

[Verify that the EUT continues transmission but signals the failure, when automatically switched to the GNSS module's position.]

Verify that the relay output signals the failure state in both case.

### **14.11.3.2 Loss or malfunction of power supply**

#### **Method of measurement**

Modify external and internal power supplies of the EUT in such a way that its operation is degraded or terminated.

#### **Required result**

Verify that as soon as the reliable operation of the EUT becomes impossible all VHF transmissions are stopped.

Verify that the relay output signals the failure state.

### **14.11.3.3 Failure of Tx synthesisers**

#### **Method of measurement**

Prevent the Tx-synthesiser from correct locking (PLL failure)

#### **Required result**

Verify that the EUT ceases all VHF transmissions.

Verify that the relay output signals the failure state.

### **14.11.3.4 Low transmitting power and/or high VSWR**

#### **Method of measurement**

Prevent the EUT from transmitting with full power by mismatching/disconnecting the antenna and/or manipulating its power amplifier.

#### **Required result**

Verify that the EUT shall continue transmitting with reduced power as far as possible.

Verify that the relay output signals the failure state.

### **14.11.3.5 Transmitter too long on the air**

#### **Method of measurement**

Keep the transmitter of the EUT repetitively on the air for a time which is exceeding the slot length.

#### **Result**

Verify that the EUT disables the transmitter.

Verify that the relay output signals the failure state.

### **14.11.3.6 Rx malfunction**

#### **Method of measurement**

Disable each of the three receivers one at a time.

#### **Required result**

Verify that the EUT does not transmit on the disabled channel.

Verify that the relay output signals the failure state.

#### **14.11.3.7 CPU/program failure**

##### **Method of measurement**

Stop the operation of the control unit or CPU by any means.

##### **Required result**

Verify that the EUT does not transmit on any channel.

Verify that the relay output signals the failure state.

#### **14.11.3.8 GNSS module status**

##### **Method of measurement**

Apply an "off" or "not usable" status of the GNSS module to the control unit or CPU.

##### **Required result**

Verify that the EUT ceases or does not start transmission if there are no external data available which allow operation with reduced data and with conversion to indirect synchronisation.

Verify that the relay output signals the failure state.

#### **14.11.3.9 Program memory (checksum)**

##### **Method of measurement**

Load the EUT with a program which is consistent but includes incorrect checksums or other data for memory/program protection.

##### **Required result**

Verify that the EUT detects the error and outputs corresponding alarms.

Verify that the relay output signals the failure state.

#### **14.11.3.10 Stored variable data (checksum)**

##### **Method of measurement**

Load the EUT with variable data (e.g. user inputs) which are consistent. Manipulate data in memory to corrupt checksums or other data provided for variable data protection.

##### **Required result**

Verify that the EUT detects the error and outputs corresponding alarms.

Verify that the relay output signals the failure state.

### **14.12 (\*\*5.12) Display**

#### **14.12.1 Data input/output facilities**

##### **Method of measurement**

Operate standard test environment and EUT in autonomous mode.

a) Record received messages and check size and contents of minimum display.

b) Input static and voyage related data via the minimum display

### Required results

[Minimum display shall contain 16 char/line at least (general requirements of IEC 60945 shall be achieved)]

a) Confirm that all messages including binary and safety related messages received can be displayed and that means to select messages and data fields to be displayed are available.

b) Confirm that all necessary data can be input

### 14.12.2 Initiate message transmission

#### Method of measurement

Operate standard test environment and EUT in autonomous mode. Initiate the transmission of non scheduled messages and/or interrogations as provided by the EUT.

#### Required results

Confirm that at least the transmission of safety related addressed and broadcast messages msg12 and msg14 can be initiated by means of minimum display. Confirm that transmission of messages 4, 16, 17, 19, 20, 22 is not possible.

Note: Use of messages 4, 16, 17, 19, 20, 22 is restricted to base stations.

### 14.12.3 System control

#### Method of measurement

Operate standard test environment and EUT in autonomous mode. Perform system control / configuration commands as available. Check indication of system status / alarms.

#### Required results

At least initiation of channel switching and output of User directory shall be possible with minimum display. Output power may not be switched manually. Confirm that configuration level and other functions not intended for use by the operator are protected by password or adequate means.

## 15 Physical Tests

### 15.1 TDMA Transmitter

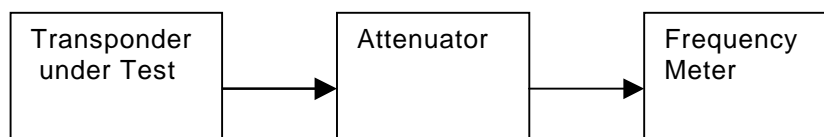
#### 15.1.1 Frequency Error

##### Definition

The frequency error of the transmitter is the difference between the measured carrier frequency in the absence of modulation and the nominal frequency of the transmitter.

##### Method of measurement

Figure 23 Measurement arrangement



The equipment shall be connected as illustrated.

The carrier frequency shall be measured in the absence of modulation. The measurement shall be made under normal test conditions and extreme test conditions.

## Required results

The frequency error shall not exceed  $\pm 3$  ppm, under normal and  $\pm 1$  kHz under extreme test conditions.

### 15.1.2 Frequency Range / Channel Availability

#### Definition

The frequency range is the maritime mobile frequency band 156 – 162.025 MHz with channel utilisation according to ITU-R M.1084-3

#### Method of measurement

Tests shall be performed on at least 3 channels (Low, Mid and High) within the frequency range if not otherwise stated.

TBD

## Required results

TBD

### 15.1.3 Channel Switching Time

#### Definition

The Channel switching time is the time it takes for the transponder transmitter to switch from being operational one channel "A" to being operational on channel "B".

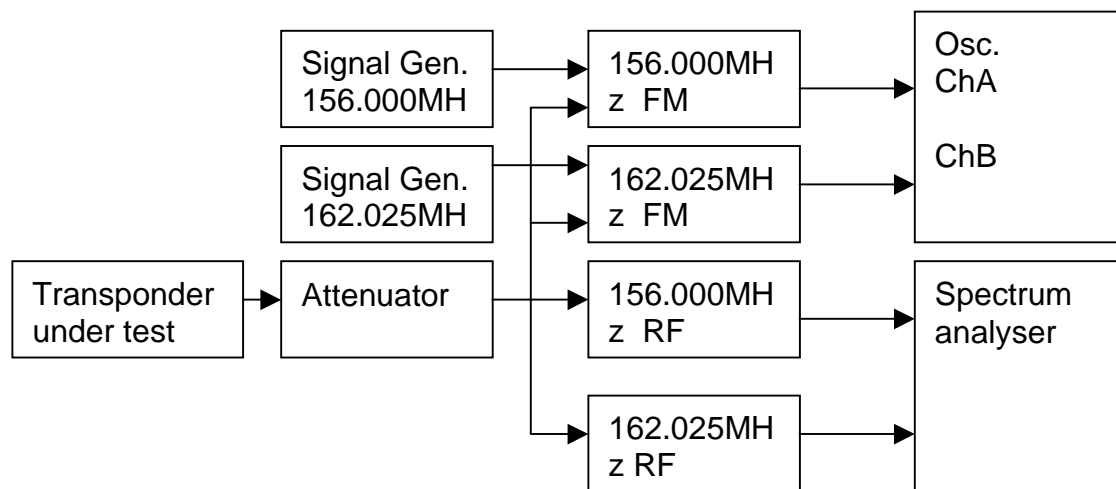
#### Method of measurement

The channel selection time shall be verified by setting the station up to transmit alternating on dual channels according to the following scheme 156.000 MHz in slot N and on 162.025 in slot N+2

**Table 65**

SLOT No.	Action
N	Transmit on 156.000 MHz
N+2	Transmit on 162.025 MHz
N+4	Transmit on 156.000 MHz
N+75	Transmit on 162.025 MHz
N+77	Transmit on 156.000 MHz
N+79	Transmit on 162.025 MHz
And so on	

**Figure 66**



### Test Set-up

#### Oscilloscope .

Set the oscilloscope horizontal scale to 10 milliseconds/division. Set the oscilloscope vertical Zero at the 50% of the scale for Ch. A and Ch. B. Set the vertical scale so that the detector output gives a  $\pm 50\%$  deflection for full scale output. Trig on Ch. A and on Ch. B. Verify that the transmissions are nominal w.r.t. Tx attack and Tx release.

#### Spectrum Analyser

Set the spectrum analyser sweep to a fixed frequency at 159.000MHz and set the filter bandwidth to 7 MHz. Adjust the spectrum analyser attenuation so that the continuous part of a transmission is equal to the reference level. Verify that the transmissions are nominal w.r.t. Tx attack and Tx release.

### Required results

The channel selection time shall be less than 20 milliseconds.

#### 15.1.4 Carrier Power

##### Definition

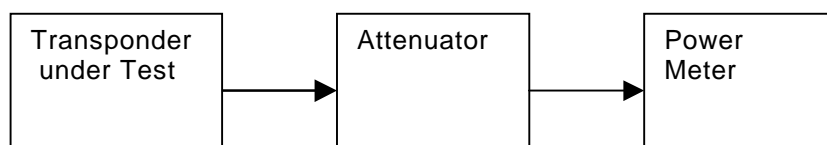
The transmitter carrier power (conducted) is the mean power delivered to a nominal 50 Ohm load during a radio frequency cycle. The rated output power is the carrier power (conducted) defined as nominal High and Low

Note: The equipment is designed to operate with different carrier powers. This measurement shall be performed at the nominal low and nominal high power setting.

##### Method of measurement

The measurement shall be carried out under normal and extreme test conditions on both high and low power settings.

**Figure 24: Measurement arrangement**



### Required results

The carrier power (conducted) shall be within  $\pm 1,5$  dB of the rated carrier power (conducted).

The carrier power (conducted) under extreme test conditions shall be within + 2,0 dB and - 3,0 dB of the rated output power.

### 15.1.5 Modulation Spectrum 25 kHz channel mode

#### Purpose

This test is produced to insure that the modulation sidebands produced by the specified test patterns, fall within the allowable masks.

#### Method of measurement

Two methods of measurements are accepted.

- a) The test shall be performed using the modulation and transmitter keying of the EUT.
- b) Alternatively, to perform this test the manufacturer shall provide access to the modulator and the transmitter key. An external test signal shall be applied to the EUT.

The test shall be carried out using standard modulation, for both DSC and TDMA modes, using successively standard test signals 1, 2 and 3. See 10.4.

Using standard modulation, for both DSC and TDMA modes, the emission mask for 25kHz channel mode is:

At  $\pm 10$ kHz removed from the carrier the modulation sidebands is below - 25dBc.

At  $\pm 25$ kHz removed from the carrier, the modulation sidebands is below - 70dBc, without any need to be below 0.25 $\mu$ W.

In the region between  $\pm 10$ kHz and  $\pm 25$ kHz removed from the carrier, the modulation sidebands is below a line specified between these two points.

## Modulation Spectrum (25kHz)

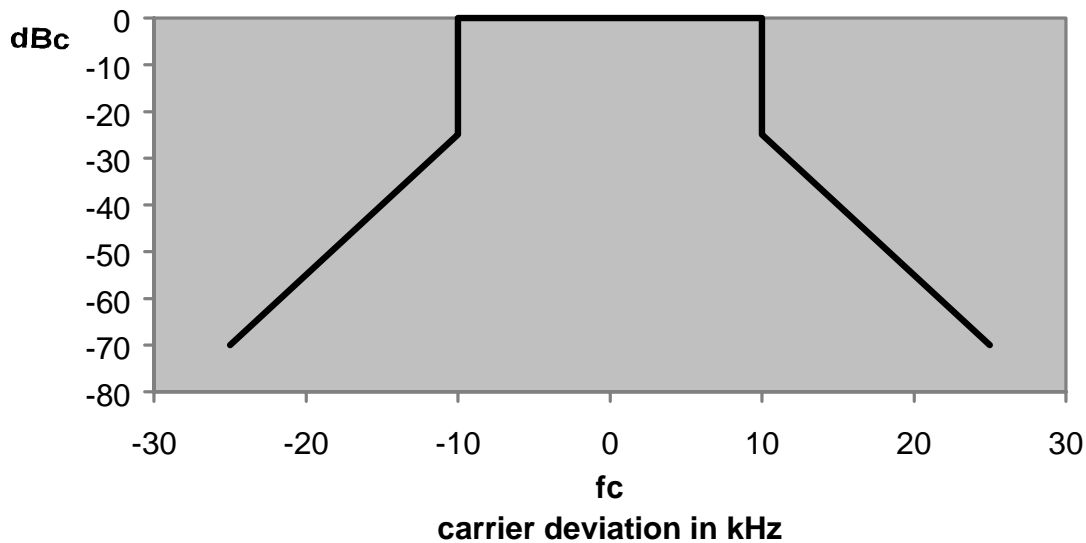


Figure 25

### Required result

The modulation spectrum shall be within the mask specified in figure Figure 25

### 15.1.6 Modulation Spectrum 12.5 kHz channel mode

#### Purpose

This test is produced to insure that the modulation sidebands produced by the specified test patterns, fall within the allowable masks.

#### Method of measurement

Two methods of measurements are accepted.

- a) The test shall be performed using the modulation and transmitter keying of the EUT.
- b) Alternatively, to perform this test the manufacturer shall provide access to the modulator and the transmitter key. An external test signal shall be applied to the EUT.

The test shall be carried out using standard modulation, for both DSC and TDMA modes, using successively standard test signals 1, 2 and 3. See 10.4.

The emission mask for 12.5kHz channel mode is:

At  $\pm 12.5$  kHz removed from the carrier, the modulation sidebands is below  $-60$  dBc

In the region between  $\pm 2.5$  kHz and  $\pm 12.5$  kHz removed from the carrier, the modulation sidebands is below a line starting at 0 dBc /  $\pm 2.5$  dBc and ending at  $-60$  dBc /  $\pm 12.5$  kHz without any need to be below  $0.25 \mu\text{W}$ .

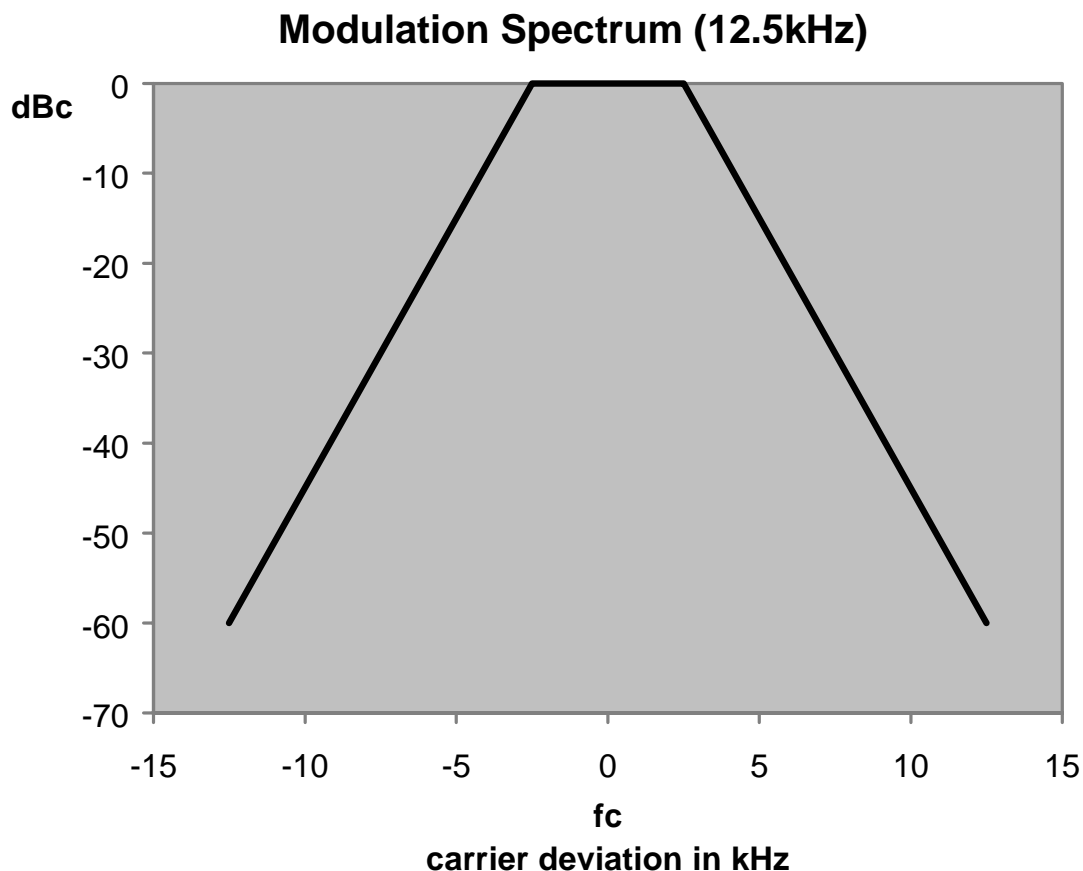


Figure 26

**Required result**

The modulation spectrum shall be within the mask specified in Figure 26.

**15.1.7 Transmission in Subsequent TDMA Slots****Purpose**

TBD.

**Method of test**

TBD.

**Required results**

The RF power shall be continuously "ON" during transmission in consecutive slots.

**15.1.8 Transmitter Attack Time****Definition**

The transmitter attack time ( $t_a$ ) is the time which elapses between the initiation of the "transmitter on" function ( $T_{x\ on}$ , see definitions in 15.1.10) and:

- The moment when the transmitter output power has reached a level 1 dB below or 1,5 dB above the steady state power ( $P_c$ ) and maintains a level within +1,5 dB / -1 dB from  $P_c$  thereafter as seen on the measuring equipment or in the plot of power as a function of time; or

b) The moment after which the frequency of the carrier always remains within  $\pm 1$  kHz of its steady state frequency,  $F_c$ , as seen on the measuring equipment or the plot of frequency as a function of time, whichever occurs later (subclause 15.1.10, figures TBD).

The measured value of  $t_a$  is  $t_{am}$ ; its limit is  $t_{al}$ .

The choice of conditions for b), above, is made in order to make the method of measurement easier to perform and to have good repeatability. Under these conditions, the frequency of the carrier shall be within the frequency tolerance of the steady state,  $d_{fe}$ , a few ms after the end of the attack time as defined in b) above.

### Method of measurement

The measurement is carried out with an unmodulated carrier.

The measurement procedure shall be as follows:

a) The transmitter is connected to a RF detector and to a test discriminator via a matched test load. The attenuation of the test load shall be chosen in such a way that the input of the test discriminator is protected against overload and the limiter amplifier of the test discriminator operates correctly in the limiting range as soon as the transmitter carrier power (before attenuation) exceeds 1 mW. A dual trace storage oscilloscope (or a transient recorder) records the amplitude transient from the detector on a logarithmic scale and the frequency transient from the discriminator;

A trigger device may be required to ensure that the start of the sweep of the oscilloscope time base occurs at the instant at which the "transmitter on" function is initiated. The measuring arrangement is shown in figure TBD\*\*\* of 15.1.10.

A spectrum analyser and a test discriminator/storage oscilloscope can also be used.

b) The traces of the oscilloscope shall be calibrated in power and frequency (y-axes) and in time (x-axis), using the signal generator;

c) The transmitter attack time may (preferably) be measured by direct reading on the oscilloscope while the transmitter is unmodulated.

### Required result

The transmitter attack time shall not exceed 1 ms ( $t_{am} \leq t_{al}$ ).

## 15.1.9 Transmitter Release Time

### Definition

The transmitter release time ( $t_r$ ) is the time which elapses between the initiation of the "transmitter off" function ( $T_{xoff}$ , see definitions in subclause TBD) and the moment when the transmitter output power has reduced to a level 50 dB below the steady state power ( $P_c$ ) and remains below this level thereafter as seen on the measuring equipment or in the plot of power as a function of time (subclause TBD, figure TBD).

The measured value of  $t_r$  is  $t_{rm}$ ; its limit is  $t_{rl}$ .

### Method of measurement

For the test arrangement, see subclause 15.1.10, figure [TBD].

The measurement is carried out with an unmodulated carrier.

The measurement procedure shall be as follows:

a) The transmitter is connected to a RF detector and to a test discriminator via a matched power attenuator. Its attenuation shall be chosen in such a way that the input of the test discriminator is protected against overload and that the limiter amplifier of the test discriminator operates correctly in

the limiting range as long as the transmitter carrier power (before attenuation) exceeds 1 mW. A dual trace storage oscilloscope (or a transient recorder) records the amplitude transient from the detector on a logarithmic scale and the frequency transient from the discriminator. A trigger device may be required to ensure that the start of the sweep of the oscilloscope timebase occurs the instant at which the "transmitter off" function is initiated. If the transmitter possesses an automatic powering down facility (e.g. in the case of fixed length message transmission), it may replace the trigger device for starting the sweep of the oscilloscope. The measuring arrangement is shown in figure TBD of subclause TBD;

A spectrum analyser and a test discriminator/storage oscilloscope can also be used.

- b) The traces of the oscilloscope shall be calibrated in power and frequency (y-axes) and in time (x-axis) by replacing the transmitter and test load by the signal generator;
- c) The transmitter release time shall be measured by direct reading on the oscilloscope while the transmitter is preferably unmodulated.

### Required result

The transmitter release time shall not exceed 1 ms ( $t_{rm} \leq t_{rl}$ ).

## 15.1.10 Transient Behaviour - Time domain analysis of power and frequency

### Clarification

Limitations of the transmitter attack and release times (subclauses TBD and TBD) are intended to improve the spectrum efficiency. The attack and release times can also be used to allow the definition of the timings in the protocols.

The measurements of transient behaviour are intended to ensure that the transmitter will not cause harmful interference in the other channels when the operating frequency is outside the tolerance of the steady state  $df_e$ .

The method of measurement includes:

- The drawing of plots of "carrier power as a function of time" and "carrier frequency as a function of time";
- The evaluation of the slopes of those plots between predetermined points;
- The measurement of the transient power in the adjacent channels.

### Definition

The transient behaviour of the transmitter is defined as the time-dependency of transmitter frequency, power and spectrum when the RF output power is switched on and off.

The following powers, frequencies, frequency tolerances and transient times are specified:

$P_o$  : rated power;

$P_e$  : steady state power;

$P_a$  : adjacent channel transient power. It is transient power falling into the adjacent channels due to switching the transmitter on and off (subclause TBD);

$F_o$  nominal carrier frequency;

$F_e$  : steady state carrier frequency;

$dF$ : frequency difference (relative to  $F_e$ ) or frequency error (absolute) (subclause \*\*\*8.1.1), of the transmitter;

[ $dF_e$ : limit of the frequency error ( $dF$ ) in the steady state (subclause \*\*\*5.1.1);]

[ $dF_e$ : limit of the frequency difference ( $dF$ ) equal to 1 kHz. If it is impossible to switch off the transmitter modulation one half channel separation is added;]

[ $dF_e$ : limit of the frequency difference ( $dF$ ) during the transient, equal to one half channel separation; while the frequency difference is less than  $dF_e$ , the carrier frequency remains

within the boundaries of the allocated channel. If it is impossible to switch off the transmitter modulation another half channel separation is added;]

$T_{xon}$  : time at which the final irrevocable logic decision to power on the transmitter is taken.

If an access point is unavailable then the time after which the carrier power exceeds ( $P_c - 50$  dB) may be taken. This fact shall be recorded in the test report.

The power starts to rise somewhere between  $T_{xon}$  and  $t_{on}$  (RF-power on).

$t_{on}$  : time when the carrier power, measured at the transmitter output, exceeds  $P_c - 30$  dB;

$t_p$  : period of time starting at  $t_{on}$  and finishing when the power reaches  $P_c - 6$  dB;

$t_a$  : transmitter attack time as defined in 15.1.8;

$t_{am}$  : measured value of  $t_a$  ;

$t_{al}$  : limit of  $t_{am}$  as given in 15.1.8;

$T_{xoff}$  : time at which the final irrevocable logic decision to power off the transmitter is taken.

If an access point is unavailable then the time after which the carrier power remains below ( $P_c - 3$  dB) may be taken. This fact shall be recorded in the test report.

The power starts to decrease somewhere between  $T_{xoff}$  and the moment when  $P_c - 6$  dB is reached (RF-power off).

$t_{off}$  : time when the carrier power falls below  $P_c - 30$  dB;

$t_d$  : period of time starting when the power falls below  $P_c - 6$  dB and finishing at  $t_{off}$ ;

$t_r$  : transmitter release time as defined in 15.1.9 (after the end of the release time, the power remains below  $P_c - 50$  dB);

$t_{rm}$  : measured value of  $t_r$ ;

$t_{rl}$  : limit of  $t_{rm}$  as given in 15.1.9.

If use is made of a synthesiser and/or a Phase Locked Loop (PLL) system for determining the transmitter frequency, then the transmitter shall be inhibited when synchronisation is absent or in the case of PLL, when the loop system is not locked.

## Method of measurement

Figure 27 represent the timings, frequencies and powers as defined in subclauses.

TBD

## Required result

[The plots of carrier power (conducted) and carrier frequency as a function of time, covering in an appropriate way the transients, shall be included in the test report. At any time when the carrier power is above  $P_c - 30$  dB, the carrier frequency shall remain within half a channel separation ( $df_c$ ) from the steady carrier frequency ( $F_c$ ). The slopes of the plots "power as a function of time" corresponding to both attack and release times, shall be such that:

$t_p \geq 0,20$  ms and  $t_d \geq 0,20$  ms, for attack and release time.

between the  $P_c - 30$  dB point and the  $P_c - 6$  dB point, both in the case of attack and release time, the sign of the slope shall not change.

The transient power, in the adjacent channels shall not exceed a value of

- 60,0 dB below the carrier power (conducted) of the transmitter in decibels relative to the carrier power (dBc) without the need to be below 2  $\mu$ W (- 27,0 dBm), for channel separations of 25 kHz;
- [50,0] dB below the carrier power (conducted) of the transmitter (in dBc) without the need to be below 2  $\mu$ W (- 27,0 dBm), for a channel separation of 12,5 kHz.]

TBD

**Figure 27: Transmitter attack time according to subclause TBD a) and transient behaviour during switch-on. (Case where the attack time is given by the behaviour of the power rise)**

### 15.1.11 Transient Behaviour - Time domain analysis of power and frequency

#### Definition

TBD

#### Method of measurement

TBD and figures TBD

#### Required results

The test is carried out with an unmodulated carrier

The plots of carrier power (conducted) and carrier frequency as a function of time, covering in an appropriate way the transients, shall be included in the test report.

At any time when the carrier power is above  $P_c - 30$  dB, the carrier frequency shall remain within half a channel separation ( $dF_c$ ) from the steady carrier frequency ( $F_c$ ).

The slopes of the plots "power as a function of time" corresponding to both attack and release times, shall be such that:

$$t_p \geq 0,20 \text{ ms and } t_d \geq 0,20 \text{ ms, for attack and release time;}$$

between the  $P_c - 30$  dB point and the  $P_c - 6$  dB point, in both cases of attack and release time, the sign of the slope shall not change.

### 15.1.12 Transient Behaviour - Adjacent channel transient power

#### Definition

TBD and figures TBD.

#### Method of test

The test is carried out with an unmodulated carrier. TBD

#### Required results

The transient power, in the adjacent channels shall not exceed a value of:

60,0 dB below the carrier power (conducted) of the transmitter in decibels relative to the carrier power (dBc) without the need to be below 2  $\mu$ W (- 27,0 dBm), for channel separations of 25 kHz;

[50,0] dB below the carrier power (conducted) of the transmitter (in dBc) without the need to be below 2  $\mu$ W (- 27,0 dBm), for a channel separation of 12,5 kHz.

## 15.2 DSC Transmitter

### 15.2.1 Frequency error of the DSC Signal

#### Purpose

To measure the frequency error for the B (2100Hz) and Y (1300Hz) state which is the difference between the measured frequency from the demodulator and the nominal values.

**Method of measurement**

The transmitter shall be connected to the artificial antenna as specified in subclause \*\*\*TBD and suitable FM demodulator. The transmitter shall be set to channel 70.

The equipment shall be set to transmit a continuous B or Y state.

The measurement shall be performed by measuring the modulated output, for both the continuous B and Y state.

The measurements shall be carried out under normal and extreme test conditions.

**Required results**

TBD

**15.2.2 Modulation Rate****Purpose**

To measure the modulation rate, defined as the bit stream speed measured in bit/s.

**Method of Measurement**

The equipment shall be set to transmit continuous dot pattern. The RF output terminal of the equipment shall be connected to a linear FM demodulator followed by a suitable FSK demodulator.

**Required results**

The baud rate shall be 1200 bits/sec  $\pm$  30 ppm.

**15.3 TDMA Receivers****15.3.1 Frequency Range****Definition**

TBD

**Method of measurement**

TBD

**Required results**

The frequency range shall be 156 – 162.025 MHz with channel utilisation according to M.1084-3.

**15.3.2 Channel Switching Time****Definition**

TBD

**Method of measurement**

TBD

**Required results**

The channel selection time shall be less than [20 milliseconds].

### 15.3.3 Sensitivity – 25kHz Operation

#### Definition

The maximum usable sensitivity (data or messages, conducted) is the minimum level of signal (dBm) at the receiver input, produced by a carrier at the nominal frequency of the receiver, modulated with the normal test signal, which will, without interference, produce after demodulation a data signal with a specified packet error rate (PER).

#### Method of Measurement

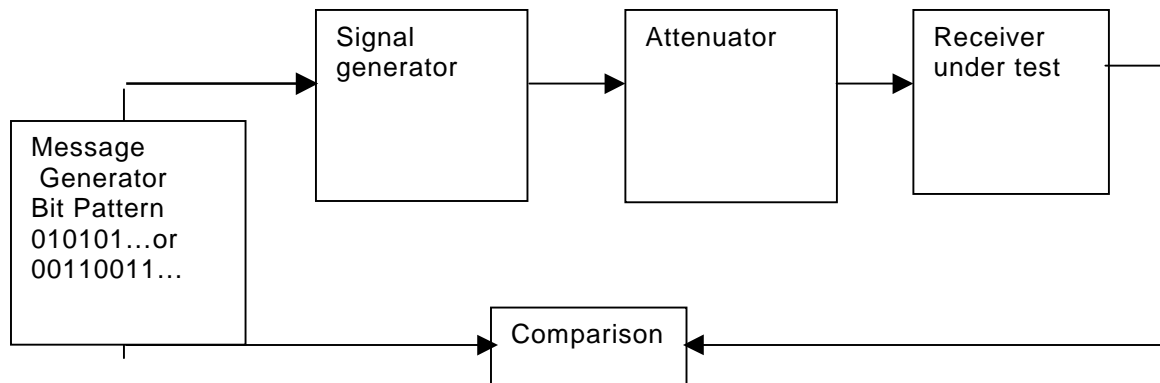


Figure 28

Parameter	Bits
Preamble	24
Start flag	8
Data	168
CRC	16
End flag	8
Total	224

Table 67

Two (2) types of packets shall be used: one which has a data field with a bit pattern consisting of alternating ones and zeroes (101010101...), one, which has a bit pattern with alternating double ones and double zeroes (110011001100...). The test shall alternate between the two types during the test process.

*Note-* It is allowed to use a broadcast binary message structure for this test. In this case, the data field is reduced by 40 bits, which will be occupied by the message id for broadcast binary message and the unique identifier for the transmitting station (MMSI). The application identifier shall be selected so that it corresponds with the selected bit pattern.

A minimum of 1000 packets shall be transmitted during the test. The PER shall be derived by dividing the received packets with the number of transmitted packets.

#### Required results

The sensitivity shall be  $-107$  dBm under normal test conditions, and  $-101$  dBm under extreme test conditions, when operating on a 25 kHz channel with a PER of 20% (This corresponds to a BER of  $10^{-3}$ ).

### 15.3.4 Sensitivity – 12.5kHz Operation

#### Definition

The maximum usable sensitivity (data or messages, conducted) is the minimum level of signal (dBm) at the receiver input, produced by a carrier at the nominal frequency of the receiver, modulated with the normal test signal, which will, without interference, produce after demodulation a data signal with a specified packet error rate (PER).

**Method of measurement**

Use the method of 15.3.3

**Required result**

The sensitivity shall be  $-104$  dBm under normal test conditions, and  $-98$  dBm under extreme test conditions, when operating on a 12.5 kHz channel with a PER of 20% (This corresponds to a BER of  $10^{-3}$ ).

**15.3.5 Error Behaviour at High Input Levels****Definition**

The error behaviour (performance) at high input levels (noise free operation) is defined in the same manner as for the measurement of the maximum usable sensitivity when the level of the wanted signal is significantly above the maximum wanted sensitivity.

**Method of measurement**

The measurement procedure shall be as follows:

- a) an input signal with a frequency equal to the nominal frequency of the receiver, having normal test modulation (see 10.4.2 and 10.4.3), in accordance with the instructions of the manufacturer and agreed by the testing laboratory, shall be applied to the receiver input terminals;
- b) the level of the input signal shall be adjusted to a level which is  $-77$  dBm for the degradation measurements;
- c) the normal test signal shall then be transmitted 100 times whilst observing in each case whether or not a message is successfully received;
- d) the number of messages not successfully received shall be recorded;
- e) the measurement shall be repeated with the input signal of the receiver at a level of  $-7$  dBm for the degradation measurements.

**Required results**

The number of messages not correctly received (lost or corrupted) shall not exceed 1 at  $-7$  dBm.

**15.3.6 Co-Channel Rejection – 25kHz Operation****Definition**

The co-channel rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due the presence of an unwanted modulated signal, both signals being at the nominal frequency of the receiver.

**Method of measurement**

TBD

**Required result**

The value of the co-channel rejection ratio, expressed in dB, at the signal displacements given in the method of measurement, shall be between  $-8,0$  dB and  $0$  dB. Any positive value is also acceptable.

**15.3.7 Co-Channel Rejection – 12.5kHz Operation****Definition**

The co-channel rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due the presence of an unwanted modulated signal, both signals being at the nominal frequency of the receiver.

## Method of measurement

TBD

## Required result

The value of the co-channel rejection ratio, expressed in dB, at the signal displacements given in the method of measurement, shall be between [- 15,0 dB] and 0 dB. Any positive value is also acceptable.

### 15.3.8 Adjacent Channel selectivity - 25kHz Operation

#### Definition

The adjacent channel selectivity is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted signal which differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended.

#### Method of measurement

TBD

#### Required results

The adjacent channel selectivity shall be no less than the values given in table [TBD].

Channel separation	25 kHz
Normal test conditions	70,0 dB
Extreme test conditions	60,0 dB

**Table 68: Adjacent channel selectivity**

### 15.3.9 Adjacent Channel selectivity - 12.5kHz Operation

#### Definition

The adjacent channel selectivity is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted signal which differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended.

#### Method of measurement

TBD

#### Required results

The adjacent channel selectivity shall be no less than the values given in table TBD.

Channel separation	12,5 kHz
Normal test conditions	[60,0] dB
Extreme test conditions	[50,0] Db

**Table 69: Adjacent channel selectivity**

### 15.3.10 Spurious Response Rejection

#### Definition

The spurious response rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal at any other frequency, at which a response is obtained.

**Method of test**

TBD

**Required results**

At any frequency separated from the nominal frequency of the receiver by two channels or more, the spurious response rejection shall not be less than 70,0 dB.

**15.3.11 Intermodulation response rejection – No.1****Definition**

The intermodulation response rejection is a measure of the capability of the receiver to receive a wanted modulated signal, without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

**Method of test**

TBD

**Required results**

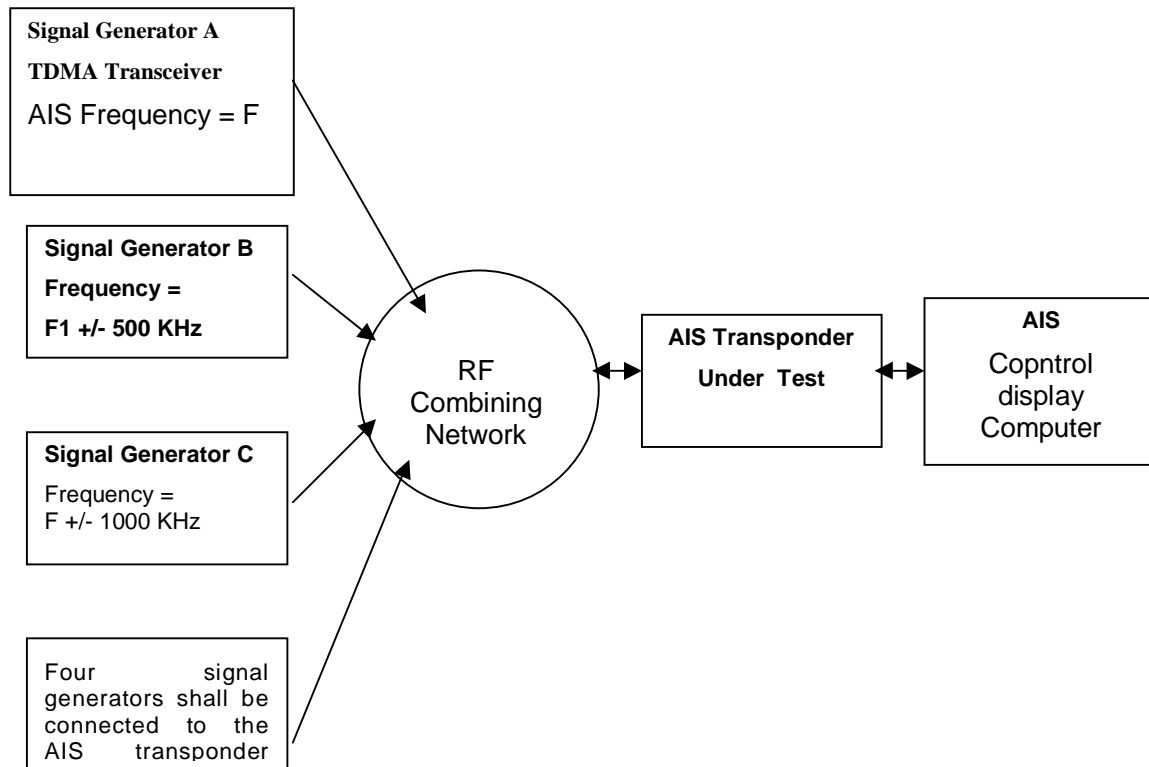
The intermodulation response rejection ratio shall not be less than 65.0 dB.

**15.3.12 Intermodulation response rejection – No.2****Definition**

[The reporting efficiency is defined as the percentage of expected position reports that an AIS transponder receives and transmits versus the number of reports expected in a measured amount of time.]

**Method of test**

Four signal generators shall be connected to the AIS transponder under test (see Figure TBD\*\*). The wanted signals, represented by signal generator A, shall be set up in accordance with the packet error rate measurement (see paragraph TBD) to the TDMA AIS test in accordance with TABLE 1.. The wanted signal levels at the RF input of the AIS transponder shall be set to -107 dBm/-101 dBm.



**Figure 29: Test set-up**

The unwanted signal from signal generator B shall be modulated by 400Hz with a deviation of +/-3 kHz and adjusted to a frequency 500 kHz above or below the frequency of the AIS1 channel. The unwanted signal from signal generator C shall be unmodulated and adjusted to a frequency 1000 kHz above or below the frequency of the AIS channel. The unwanted signal levels from signal generators B and C at the RF input of the AIS transponder shall be set to -27 dBm.

The unwanted signal from signal generator D shall be unmodulated and adjusted to a frequency 5.725 MHz above or below the frequency of the AIS channel. The unwanted signal level from signal generator D at the RF input of the AIS transponder shall be set to -15 dBm.

	Generator A	Generator B	Generator C	Generator D
<b>Test #1</b>	156.025	156.525	157.025	161.750
<b>Test #2</b>	162. 025	161.525	161.025	156.300

**Table 70**

### Required results

The packet error rate, with the outputs of signal generators B, C, and D switched on, shall be in accordance with paragraph TBD.

### 15.3.13 Blocking or Desensitisation

#### Definition

Blocking is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted input signal at any frequencies other than those of the spurious responses or the adjacent channels.

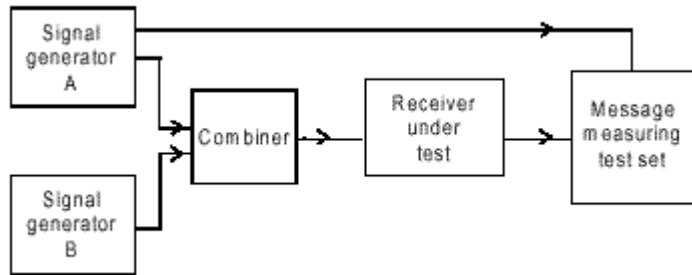


Figure 30: Test set-up

#### Method of measurement

The measurement procedure shall be as follows:

- a) Two signal generators, A and B, shall be connected to the receiver via a combining network. The wanted signal, provided by signal generator A, shall be at the nominal frequency of the receiver and shall have normal test modulation. The unwanted signal, provided by signal generator B, shall be unmodulated and shall be at a frequency from 1 MHz to 10 MHz away from the nominal frequency of the receiver. For practical reasons the measurements shall be carried out at frequencies of the unwanted signal at approximately  $\pm 1$  MHz,  $\pm 2$  MHz,  $\pm 5$  MHz and  $\pm 10$  MHz, avoiding those frequencies at which spurious responses could occur.
- b) Initially, signal generator B (unwanted signal) shall be switched off (maintaining the output impedance); The level of the wanted signal from generator A shall be adjusted to the level which is 3 dB above the level of the limit of the maximum usable sensitivity as specified (data or messages) at the receiver input terminals (i.e.  $-107$  dBm under normal test conditions).
- c) signal generator B shall then be switched on, and the level of the unwanted signal set to  $-$  TBD dBm. The PER shall be less than 20%.

#### Required results

The blocking ratio for any frequency within the specified ranges shall not be less than 84,0 dB, except at frequencies on which spurious responses are found ([TBD]).

### 15.3.14 Transmit to receive switching time

#### Definition

TBD

#### Method of measurement

TBD

#### Required results

All TDMA Receivers shall be fully operational 1 ms after [transmitter switching off].

### 15.3.15 Spurious Radiation - Radiated

#### Definition

Spurious radiations from the receiver are emissions at any frequency, radiated by the equipment and its antenna.

Method of measurement

The level of spurious radiations shall be measured by their effective radiated power when radiated by the cabinet and structure of the equipment (cabinet radiation).

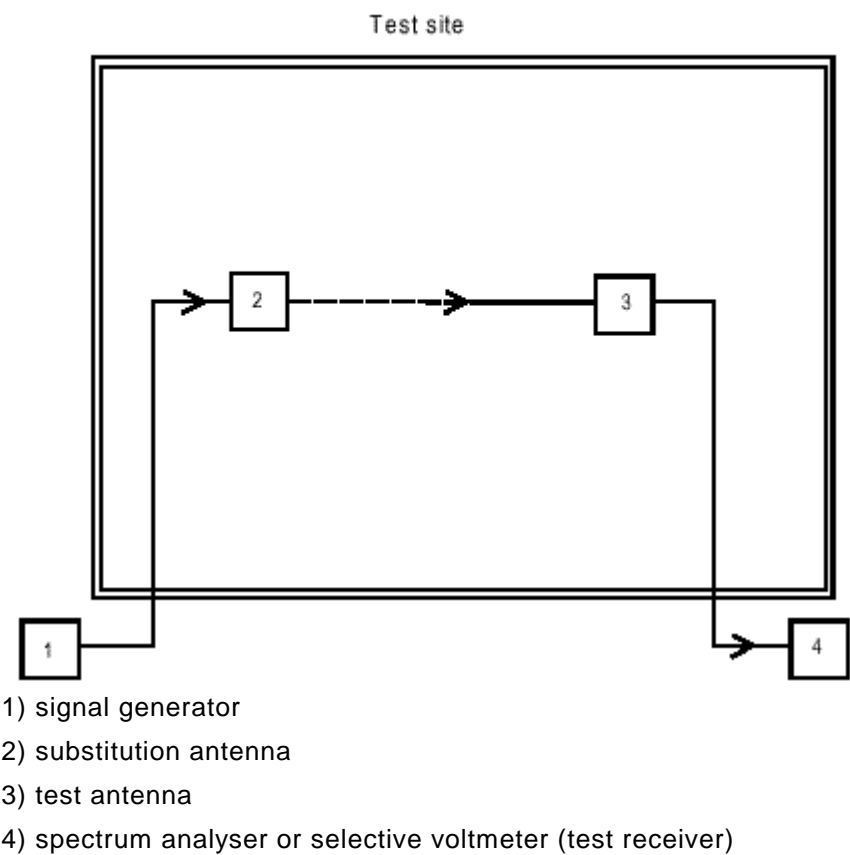


Figure 31: Measurement arrangement

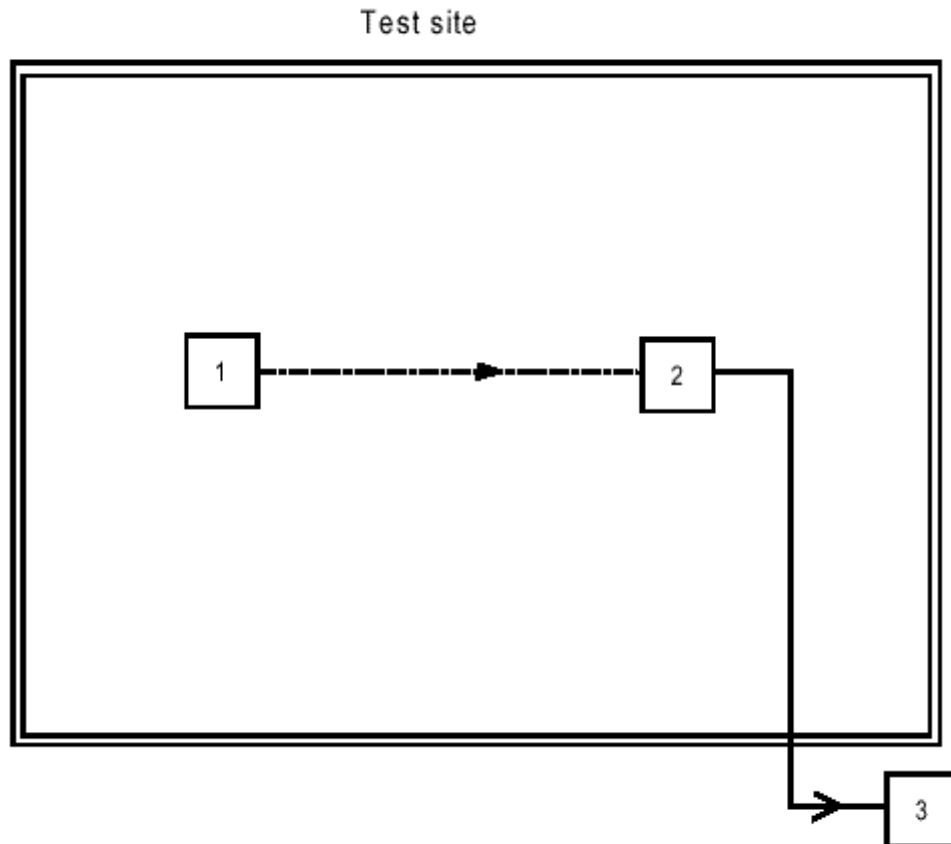
- a) at each frequency at which a component is detected, the sample shall be rotated to obtain maximum response and the effective radiated power of that component determined by a substitution measurement, using the measurement arrangement of figure TBD;
- b) the measurement shall be repeated with the test antenna in the orthogonal polarisation plane.

Required result

The power of any spurious radiation shall not exceed the values given in table TBD\*\*\*.

Table 71: Radiated emissions

Frequency range	Limit
30 MHz to 1 GHz	2,0 nW (- 57 dBm)
Above 1 GHz to 4 GHz	20,0 nW (- 47 dBm)



- 1) receiver under test
- 2) test antenna
- 3) spectrum analyser or selective voltmeter (test receiver)

**Figure 32: Test set-up**

The measurement procedure shall be as follows:

- a) on a test site, fulfilling the requirements of IEC 60945 clause 9.3, the sample shall be placed at the specified height on the non-conducting support. The receiver shall be operated from a power source via a radio frequency filter to avoid radiation from the power leads;
- b) the receiver shall be connected to an artificial antenna for equipment having an external antenna connector; or to the integral antenna;
- c) radiation of any spurious components shall be detected by the test antenna and receiver, over the frequency range 30 MHz to 2 GHz;

## **15.4 DSC Receiver**

### **15.4.1 Maximum Sensitivity**

#### **Purpose**

To measure the calling sensitivity of the receiver, which is the minimum level of the signal dBm at the nominal frequency of the receiver which when applied to the receiver input with a test modulation will produce a bit error rate of  $10^{-2}$ .

#### **Method of measurement**

The equipment shall be set to transmit continuous dot pattern. The RF output terminal of the equipment shall be connected to a linear FM demodulator followed by a suitable FSK demodulator.

**Required result**

The maximum usable sensitivity shall not exceed  $-107$  dBm under normal test conditions, and  $-101$  dBm under extreme test conditions. The test shall be repeated at the nominal carrier frequency (156,525 MHz)  $\pm 1,5$  kHz.

**15.4.2 Error Behaviour at High Input Levels****Purpose**

To measure the dynamic range of the equipment, which is the range from the minimum to the maximum level of a radiofrequency input signal at which the bit error rate in the output of the receiver does not exceed a specified value.

**Method of measurement**

A test signal, in accordance with standard test signal number 1, shall be applied to the receiver input. The level of the test signal shall be  $-7$  dBm.

**Required result**

The number of messages not correctly received (lost or corrupted) shall not exceed 1.

**15.4.3 Co-Channel Rejection****Definition**

The co-channel rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal, both signals being at nominal frequency of the receiver.

**Method of measurement**

The wanted signal shall be standard test signal number 2. The level of the wanted signal shall be  $-104$  dBm.

The unwanted signal shall be modulated by 400 Hz with a deviation of  $\pm 3$  kHz. The input level of the unwanted signal shall be  $-112$  dBm.

Both input signals shall be at the nominal frequency of the receiver under test and the measurement shall be repeated for displacements of the unwanted signal of up to  $\pm 3$  kHz.

**Required result**

The value of the co-channel rejection ratio, expressed in dB, at the signal displacements given in the method of measurement, shall be between  $-8,0$  dB and  $0$  dB.

**15.4.4 Adjacent Channel selectivity****Purpose**

To measure the adjacent channel selectivity, which characterises the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal that differs in frequency from the wanted signal by 25 kHz.

**Method of measurement**

The wanted signal shall be standard test signal number 1. The level of the wanted signal shall be  $-104$  dBm.

The unwanted signal shall be modulated by 400 Hz with a deviation of  $\pm 3$  kHz. The input level of the unwanted signal shall be  $-34$  dBm. The unwanted signal shall be tuned to the centre frequency of the upper adjacent channels.

The measurement shall be repeated with the unwanted signal tuned to the centre frequency of the lower adjacent channel.

### Required result

The adjacent channel selectivity for different channel separations shall not be less than the values given in Table 72.

**Table 72: Adjacent channel selectivity DSC**

Normal test conditions	70,0 dB
Extreme test conditions	60,0 dB

## 15.4.5 Spurious Response Rejection

### Purpose

To measure the spurious response, which characterises the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal with frequencies outside the passband of the receiver.

### Method of measurement

The wanted signal shall be standard test signal number 1. The level of the wanted signal shall be  $-104$  dBm.

The unwanted signal shall be unmodulated. The frequency shall be varied between  $-2$  GHz and  $-9$  kHz and also between  $9$  kHz and  $2$  GHz relative to the nominal frequency of the wanted signal. The level of the unwanted signal shall be  $-24$  dBm.

### Required result

At any frequency separated from the nominal frequency of the receiver by two channels or more, the spurious response rejection shall not be less than  $70,0$  dB.

## 15.4.6 Intermodulation response Rejection

### Purpose

To measure the inter-modulation response ratio, which characterises the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

### Method of measurement

The wanted signal represented by signal generator A shall be at the nominal frequency of the receiver and shall be standard test signal number 1. The level of the wanted signal shall be  $-104$  dBm.

The unwanted signal from signal generator B shall be unmodulated and adjusted to a frequency  $50$  kHz above the nominal frequency of the receiver. The second unwanted signal from signal generator C shall be modulated by  $400$  Hz with a deviation of  $\pm 3$  kHz and adjusted to a frequency  $100$  kHz above the nominal frequency of the receiver. The input level of each unwanted signal shall be  $-39$  dBm. The test shall be repeated with the frequency of the unwanted signals below the nominal frequency of the receiver.

**Required result**

The intermodulation response rejection ratio shall not be less 65,0 dB.

**15.4.7 Blocking or Desensitisation****Purpose**

To measure the blocking immunity, which characterises the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal with frequencies outside the passband of the receiver.

**Method of measurement**

The wanted signal shall be standard test signal number 2. The level of the wanted signal shall be –104 dBm.

The unwanted signal shall be unmodulated. The frequency shall be varied between –10 MHz and –1 MHz and also between +1 MHz and +10 MHz relative to the nominal frequency of the wanted signal. The level of the unwanted signal shall be –20 dBm.

**Required result**

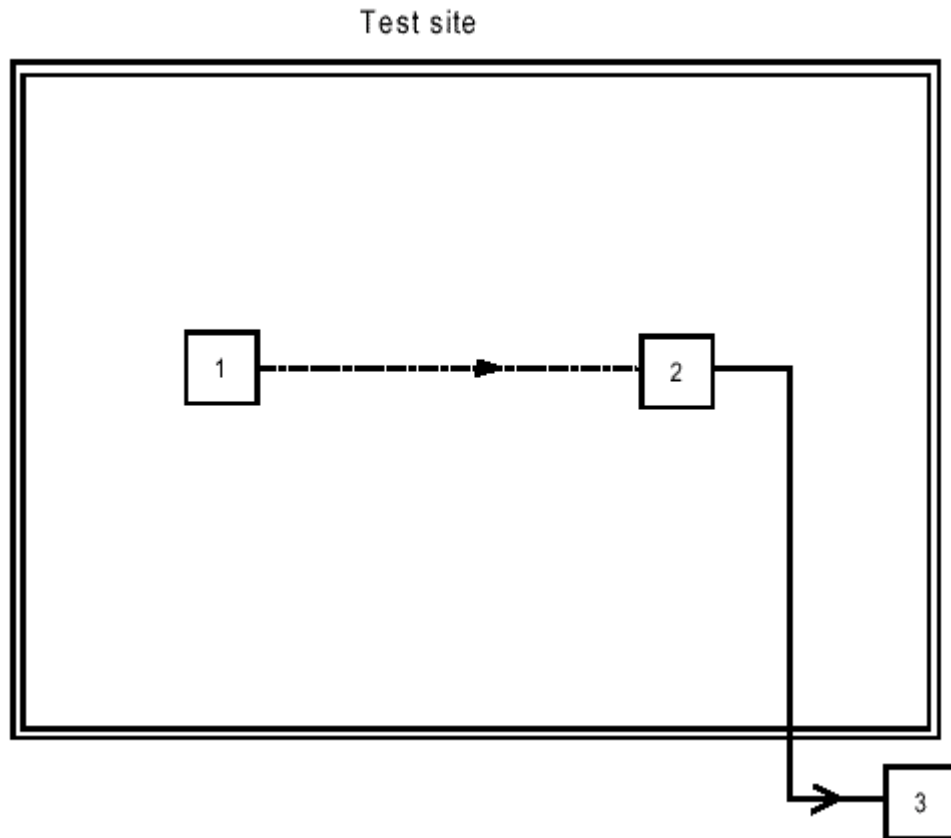
The blocking ratio for any frequency within the specified ranges shall not be less than 84,0 dB, except at frequencies on which spurious responses are found (see [TBD])

**15.4.8 Spurious Radiation - Radiated****Definition**

Spurious radiations from the receiver are emissions at any frequency, radiated by the equipment and its antenna.

**Method of measurement**

The level of spurious radiations shall be measured by their effective radiated power when radiated by the cabinet and structure of the equipment (cabinet radiation).

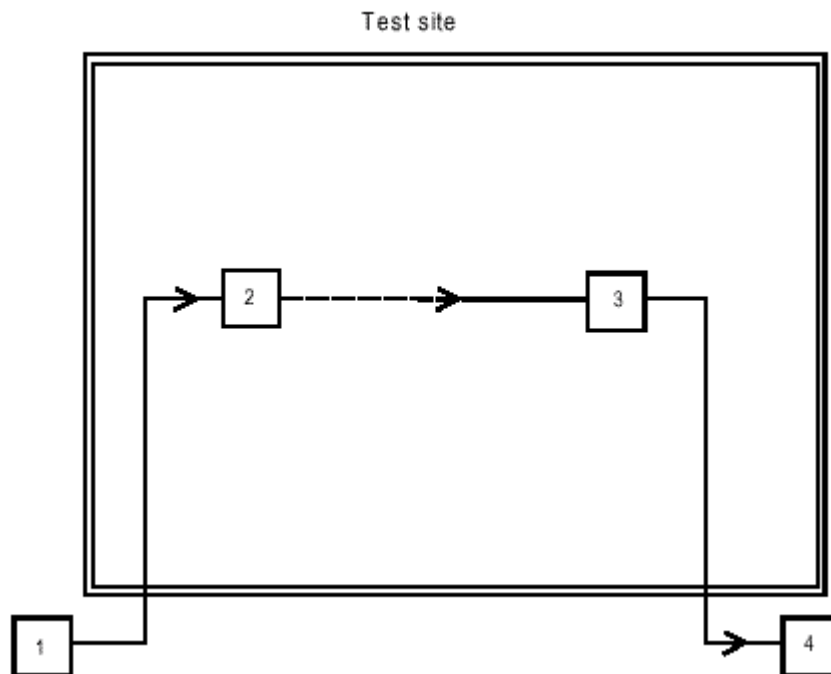


- 4) receiver under test
- 5) test antenna
- 6) spectrum analyser or selective voltmeter (test receiver)

**Figure 33: Measurement arrangement**

The measurement procedure shall be as follows:

- a) on a test site, fulfilling the requirements of IEC 60945 clause 9.3, the sample shall be placed at the specified height on the non-conducting support. The receiver shall be operated from a power source via a radio frequency filter to avoid radiation from the power leads;
- b) the receiver shall be connected to an artificial antenna for equipment having an external antenna connector; or to the integral antenna;
- c) radiation of any spurious components shall be detected by the test antenna and receiver, over the frequency range 30 MHz to 2 GHz;



- 1) signal generator
- 2) substitution antenna
- 3) test antenna
- 4) spectrum analyser or selective voltmeter (test receiver)

**Figure 34: Measurement arrangement**

- d) at each frequency at which a component is detected, the sample shall be rotated to obtain maximum response and the effective radiated power of that component determined by a substitution measurement, using the measurement arrangement of figure TBD;
- e) the measurement shall be repeated with the test antenna in the orthogonal polarisation plane.

#### Required result

The power of any spurious radiation shall not exceed the values given in table TBD\*\*\*.

**Table 73: Radiated emissions**

Frequency range	Limit
30 MHz to 1 GHz	2,0 nW (- 57 dBm)
Above 1 GHz to 4 GHz	20,0 nW (- 47 dBm)

#### Required result

The maximum usable sensitivity shall not exceed  $-107$  dBm under normal test conditions, and  $-101$  dBm under extreme test conditions. The test shall be repeated at the nominal carrier frequency (156,525 MHz)  $\pm 1,5$  kHz.

## 16 (\*\*6.3) Specific tests of Link Layer

### 16.1 (\*\*6.3.1.1, 6.3.1.3) TDMA Synchronisation

#### 16.1.1 Synchronisation test with internal UTC

#### Definition

TBD

### Method of measurement

Set up standard test environment; chose test conditions in a way that EUT operates in following sync modes:

UTC direct

UTC indirect (internal GNSS receiver disabled; at least one other station UTC direct synchronised)

BASE direct (internal GNSS disabled; no station with UTC direct synchronisation within range)

[BASE indirect (internal GNSS disabled; no station with UTC direct synchronisation or Base station within range,)]

mobile direct (internal GNSS disabled; no station with UTC direct synchronisation or Base station within range,)

Check CommState Parameter SyncState in position Report and reporting rate

### Required result

Transmitted Communication state shall fit the Synchronisation mode

#### 16.1.2 Synchronisation test without UTC

##### Definition

TBD

##### Method of measurement

Set up standard test environment without UTC available. Let EUT operate as a sync basis (semaphore) for other stations. Check CommState Parameter SyncState in position Report and reporting rate.

##### Required results

Transmitted CommState shall fit the Synchronisation mode.

The EUT shall increase reporting rate to 3 s when synchronised by a base station. Mobile station shall then alternate between messages 1 and 11.]

#### 16.1.3 Synchronisation test without UTC direct

##### Definition

TBD

##### Method of measurement:

Enable internal GNSS in synchronisation modes other than UTC direct

##### Required results

Synchronisation mode shall revert to UTC direct

#### 16.2 (\*\*6.3.1.2) Time division (Frame format)

##### Definition

TBD

### Method of measurement

Set the EUT to max reporting rate of 2 sec by applying a speed of >23kn and a ROT of >20°/sec. Record VDL messages and check for used slots. Check parameter slot number in CommState of position report. Check slot length (transmission time)

### Required results

Slot number used and slot number indicated in CommState shall match. Slot number shall not exceed 2249. slot length shall not exceed 26,67msec.

Note: The requirements of 6.3.2 for HDLC, bit stuffing, training sequence, etc are covered by the above tests and by the operational tests.

## 16.3 (\*\*6.3.2.2.6) Frame check sequence

### Definition

TBD

### Method of measurement

Apply a simulated position report message with wrong CRC bit sequence to the VDL.

### Required results

Confirm that this message is not forwarded to the PI by the EUT.

## 16.4 (\*\*6.3.3.3) Initialisation period

### Definition

TBD

### Method of measurement:

Set up standard test environment; switch on EUT. Initiate output of User directory after 1min and check contents. Record all messages on VDL.

### Required results

EUT shall start autonomous transmissions of msg1 (position report) after 1min with default reporting rate. User directory shall contain all AIS presently in VDL.

## 16.5 (\*\*6.3.3) Slot allocation (Channel access protocols)

### 16.5.1 Network entry

### Definition

TBD

### Method of measurement

Set up standard test environment; switch on EUT. Record transmitted scheduled position reports for the first 3 frames after initialisation period. Check CommState for channel access mode

### Required results

EUT shall start autonomous transmissions of msg1 (position report) with ITDMA CommState with KeepFlag set true for first frame and SOTDMA CommState for consecutive frames.

### 16.5.2 Autonomous scheduled transmissions (SOTDMA)

#### Definition

TBD

#### Method of measurement

Operate standard test environment and EUT in autonomous mode. Record transmitted scheduled position reports and check frame structure. Check CommState of transmitted messages for channel access mode and parameters slot timeout, slot number and slot offset

#### Required results

Check that nominal reporting rate is achieved  $\pm 20\%$  (allocating slots in selection interval SI). Confirm that the EUT allocates new slots NTS within SI after 3 to 8min. Check that slot offset indicated in CommState matches slots used for transmission.

### 16.5.3 Single message transmission (RATDMA)

#### Definition

TBD

#### Method of measurement

Operate standard test environment and EUT in autonomous mode. Apply a 1 slot Binary Broadcast Message msg8 to the PI of the EUT. Record transmitted messages.

#### Required results

[Confirm that EUT transmits this msg8 within max. 4sec]. [Retry with 90% channel load.]

### 16.5.4 Assigned operation

#### 16.5.4.1 Receiving test

##### Definition

TBD

##### Method of measurement

Operate standard test environment and EUT in autonomous mode. Transmit an Assigned mode command message msg16 to the EUT with:

- slot offset and increment
- designated reporting rate.

Record transmitted messages.

##### Required results

Confirm that EUT transmits position report messages msg2 according to defined parameters and reverts to SOTDMA msg1 with standard reporting rate after 4 to 8 min.

#### 16.5.4.2 Transmitting test

##### Method of measurement

Operate standard test environment and EUT in autonomous mode; check frame structure. Transmit an Assigned mode command message msg16 to another AIS with a slot offset and increment pointing to a slot used by the EUT. Record transmitted messages.

**Required results**

Confirm that EUT does not use slots allocated to other stations.

**16.5.5 Fixed allocated transmissions (FATDMA)****Definition**

TBD

**Method of measurement**

Operate standard test environment and EUT in autonomous mode. Transmit a Data Link Management message msg20 to the EUT with slot offset and increment. Record transmitted messages.

**Required results**

Confirm that EUT does not use slots allocated by msg20 for own transmissions until timeout of 4 to 8 min.

**16.6 (\*\*6.3.3.8) Message Formats****16.6.1 Received messages****Method of measurement**

Operate standard test environment and EUT in autonomous mode. Apply messages according to message table 6.3.3.8.1 to the VDL. Record messages output by the PI of EUT.

**Required results**

Confirm that EUT outputs corresponding message with correct field contents and format via the PI or responds as appropriate.

**16.6.2 Transmitted messages****Method of measurement**

Operate standard test environment and EUT in autonomous mode. Initiate the transmission of messages relevant for a mobile station according to message table 6.3.3.8.1 by the EUT. Record transmitted messages.

**Required results**

Confirm that EUT transmits messages with correct field contents and format or responses as appropriate. Confirm that messages 4, 16, 19, 20, 22 reserved for Base stations are NOT being sent by the EUT.

**17 (\*\*6.4) Specific tests of Network Layer****17.1 (\*\*6.4.1) Dual channel operation****17.1.1 Alternate transmissions****Method of measurement**

Operate standard test environment and EUT in autonomous mode on default channels AIS1, AIS2. Record transmitted scheduled position reports on both channels. Check CommState for slot allocation.

## **Required results**

Confirm that EUT allocates slots in both channels alternating. Repeat check for data link access period.

### **17.1.2 Interrogation responses**

#### **Method of measurement**

Operate standard test environment and EUT in autonomous mode. Apply an interrogation message15 (EUT as destination) to the VDL according to message table 6.3.3.8.1 for responses with msg5 and slot offset set to defined value on channel AIS 1. Record transmitted messages on both channels.

## **Required results**

Check that EUT transmits the appropriate interrogation response message as requested on channel AIS1. Repeat test for AIS2.

### **17.1.3 Acknowledgements**

#### **Method of measurement**

Operate standard test environment and EUT in autonomous mode. Apply an addressed binary message msg6 (EUT as destination) to the VDL on channel AIS 1. Record transmitted messages on both channels.

## **Required results**

Check that EUT transmits the appropriate acknowledgement message on channel AIS1. Repeat test for AIS2.

### **17.1.4 Addressed messages**

#### **Method of measurement**

Operate standard test environment and EUT in autonomous mode. Set up a test target for scheduled transmissions on channel AIS1 only. Initiate the transmission of an addressed binary message msg6 (test target as destination). Record transmitted messages on both channels.

## **Required results**

Check that the EUT transmits msg6 on channel AIS1. Repeat test for AIS2.

### **17.1.5 Other non periodic messages**

#### **Method of measurement**

Operate standard test environment and EUT in autonomous mode. Initiate the transmission of 5 binary broadcast messages msg8. Record transmitted messages on both channels.

## **Required results**

Check that EUT transmits the msg8 messages on channels AIS1 and AIS2 alternating.

Note: Operating frequency channels are tested with 14.7

## **17.2 (\*\*6.4.1.5) Transitional mode**

#### **Method of measurement**

Operate standard test environment and EUT in autonomous mode. Apply Channel management messages msg20 to the VDL defining two adjacent regional areas A and B with different channel assignments for both regions (CH1A, CH2A, CH1B, CH2B). Let the EUT approach region A from

region B more than 5nm away from region boundary. Record transmitted messages on all 4 channels.

### **Required results**

Check that the EUT transmits and receives on the primary channels assigned for each region (CH1A, CH1B) alternating and doubling reporting rate when passing the transitional area of 5nm. EUT shall revert to default autonomous operation on CH1A, CH2A after leaving the transitional area.

## **17.3 (\*\*6.4.2.1) User directory**

### **Method of measurement**

Operate standard test environment and EUT in autonomous mode. Set up 2 additional test targets A and B at t=0min. Switch off target A at t=5min and target B at t=15min. Initiate output of User directory to the PI at t=40min and check contents. Record all messages on VDL

### **Required results**

User directory shall contain all AIS presently in VDL and test target B, but not test target A (30min history). Confirm that User directory data complies with VDL message data.

## **17.4 (6.4.2.2) Message priority handling**

### **17.4.1 Received messages**

#### **Method of measurement**

Operate standard test environment and EUT in autonomous mode. Transmit two messages of different priority from a Base station on assigned slot of channel A and from test system on same slot of channel B.

#### **Required results**

Check that the message with higher priority is forwarded to the PI first.

### **17.4.2 Received messages**

#### **Method of measurement**

Operate standard test environment and EUT in autonomous mode. Set the EUT to max reporting rate of 2 sec by applying a speed of >23kn and a ROT of >20°/sec. Record VDL messages and check for used slots. Initiate the transmission of message of different priority. Record transmitted messages on both channels.

#### **Required results**

Check that EUT transmits the messages with a minimum delay [TBD] according to their priority.

## **17.5 (\*\*6.4.4) Slot reuse (link congestion)**

### **Method of measurement**

Operate standard test environment and EUT in autonomous mode. Transmit a Data Link Management message msg20 to the EUT with slot offset and increment to allocate slots for a base station. Assure that at test receiver location the receiving level of EUT exceeds the receiving level of Test Transmitter. Record transmitted messages and check frame structure. Set up additional test targets [with fixed slot allocation] to simulate a VDL load of >90% until slot reuse by EUT is observed.

### **Required results**

Check that the nominal reporting rate for Position Report msg1 is achieved  $\pm 10\%$  (allocating slots in selection interval SI) under link congestion conditions. Confirm that the slot occupied by the most

distant station (within selection interval) is used by the slot reuse algorithm. Check that a station is not subject to slot reuse more than once a frame. Check that slots allocated by a base station are not subject to slot reuse.

## **18 (6.5) Specific tests of Transport Layer**

### **18.1 Sequencing of Addressed messages**

#### **18.1.1 Acknowledgement**

##### **Method of measurement**

Operate standard test environment and EUT in autonomous mode. Apply up to 4 addressed binary messages msg6 (EUT as destination) to the VDL. Record transmitted messages on both channels.

##### **Required results**

Confirm that EUT transmits a binary acknowledge message msg7 with the appropriate sequence numbers within 4 sec. Confirm that EUT transmit the result with an appropriate message to PI.

#### **18.1.2 Transmission Retry**

##### **Method of measurement**

Operate standard test environment and EUT in autonomous mode. Initiate the transmission of up to 4 addressed binary message by the EUT which will not be acknowledged (i.e. destination not available). Record transmitted messages.

##### **Required results**

Confirm that EUT retries the transmit after 4 sec. up to 3 times (configurable) for each addressed binary message. Confirm that EUT transmit the overall result with an appropriate message to PI.

### **18.2 Acknowledgement of Addressed safety related messages**

Repeat test under [\*\*\*9.1] with addressed safety related message.

## **19 Specific Presentation Interface Tests**

### **19.1 General**

[The EUT (Equipment Under Test) including all necessary test equipment shall be set-up and checked that it is operational before testing commences.

The manufacturer shall provide sufficient technical documentation of the EUT and its interfaces in particular.

The following tests shall be carried out under "Normal" environmental conditions as defined in IEC 60945.

Where appropriate, tests against different clauses of this and other chapters may be carried out simultaneously.]

### **19.2 Check the manufacturer's documentation**

[The following checks for formal consistency and compliance shall be made

- approved sentences against IEC 61162

- proprietary sentences against IEC 61162

- usage of fields as required for different functions including provided default values or settings

transmission intervals against IEC 61162

configuration of hardware and software if this is relevant to the interface performance and port selection

The following checks for compliance with IEC 61162

output drive capability

load on the line of inputs

electrical isolation of input circuits]

### **19.3 Electrical test**

#### **Method of test**

[Inputs configured as IEC 61162-1 or IEC 61162-2 shall be tested according to the relevant standard with regard to minimum and maximum voltage and current at the input terminals. Further the electrical isolation and the ability to withstand excessive voltages shall be tested.]

#### **Required results:**

The interfaces shall fulfil the requirements of the relevant standards.

### **19.4 Test of input sensor interface performance**

#### **Method of measurement:**

[Connect all inputs and outputs of the EUT as specified by the manufacturer. Operate inputs with simulated sensor data that are both the relevant data and additional data with formatters not provided for the relevant input. Together each input shall be loaded with 70 to 80 percent of the interface's capacity. Perform a performance check of the EUT (see \*\*\*).]

#### **Required results:**

[Verify that VDL message contents agree with the relevant [simulated] sensor data. The EUT shall show no degradation in performance and all output data shall be transmitted with no additional delay.]

### **19.5 Test of high speed output**

#### **Method of measurement:**

[Set-up standard test environment and simulate VDL-messages using test system. Record output from the EUT high speed port on a data analyser.]

#### **Required results:**

[Verify that the recorded message contents agree with the [simulated] VDL contents in accordance with IEC 61162-2.]

### **19.6 Test of high speed output**

#### **Method of measurement:**

[Set-up standard test environment and simulate VDL-messages using test system. Record output from the EUT high speed port on a data analyser.]

#### **Required results:**

Verify that the recorded message contents agree with the [simulated] VDL contents in accordance with IEC 61162-2.]

## 19.7 High speed output Interface performance

### Method of measurement:

[Operate standard test environment and EUT in autonomous mode. Increase the VDL load by adding test targets and increasing RR to >90%. Record transmitted messages and check PI output of EUT on port for "external Display" and "auxiliary Display".]

### Required results:

Confirm that EUT outputs all received messages to the PI. Repeat test for port "auxiliary display".]

## 19.8 Test of high speed input

### Method of measurement:

[Set-up standard test environment. Apply [simulated] input data, in accordance with IEC 61162-2 and Table \*\*\*40, to the EUT and record VDL output.

### Required results:

Verify that the VDL message contents agree with [simulated] input data.]

## 19.9 Test of the DGNSS interface

### Waiver

[This test shall be performed only if the internal GNSS receiver is optionally used as a backup source of position.

### Method of measurement:

Operate the EUT using its internal GNSS-module. Input differential correction data at the interface.

### Required results:

Verify that the EUT transmits corrected position data on the VDL.]

## 20 (7) DSC functionality tests

### 20.1 (7.1) General

For the tests in this section, set the EUT into autonomous mode using channels AIS1 and AIS2 with a reporting interval of 3 s.

Check with a sequence of valid calls consisting of a test signal number 1, a geographic call from ITU-R M.493, a test signal number 1, an individual call from ITU-R M.493 and a test signal number 1 that the EUT correctly receives and processes the three tests calls and its correct AIS operation is not affected by the interleaved calls.

Check that the EUT does not respond to invalid calls - incorrect MMSI position outside addressed geographic area, different course, or ship's type.

Send to the EUT a standard test signal number 1 but with symbol numbers 104 and 03 followed by values 01 and 120 (Activate alternate system with group number 1 and sequence number 120). Check that the EUT does not respond.

Send to the EUT a standard test signal number 1 but with symbol number 104 and 12 followed by a geographical position, symbol number 104 and 13 followed by a geographical position, and symbol number 104 and 09 followed by a channel number (Ch1A). The two geographical positions shall define a square of size 20 miles centred on the geographical position of the EUT. Check that the

EUT operates in autonomous mode on the commanded channel (Ch1A) for both 25 kHz and 12,5 kHz channels.

Send to the EUT a standard test signal number 1 but with symbol number 104 and 12 followed by a geographical position, symbol number 104 and 13 followed by a geographical position, symbol number 104 and 09 followed by a channel number (Ch2A) and symbol number 104 and 10 followed by a channel number (Ch2B). The two geographical positions shall define a square of size 20 miles contiguous to the previous square. Check that the EUT continues to operate in autonomous mode on the channel (Ch1A).

Send to the EUT a standard test signal number 1 but with symbol number 104 and 12 followed by a geographical position, symbol number 104 and 13 followed by a geographical position, symbol number 104 and 09 followed by a channel number (Ch3A) and symbol number 104 and 11 followed by a channel number (Ch3B). The two geographical positions shall define a square of size 20 miles contiguous to the square defined in \*\*\*21.1.6. Check that the EUT continues to operate in autonomous mode on the channel (Ch1A).

Change the geographical position of the EUT to a position which is 4,9 nautical miles from the defined geographical boundary of \*\*\*21.1.6. Check that the EUT now operates on channels Ch1A and Ch2A.

Change the geographical position of the EUT to a position which is 0,1 nautical miles inside the defined geographical boundary of \*\*\*21.1.6. Check that the EUT now operates on channels Ch2A and Ch2B.

Change the geographical position of the EUT to a position which is 4,9 nautical miles from the defined geographical boundary of \*\*\*21.1.7. Check that the EUT now operates on channels Ch2A and Ch3A.

Change the geographical position of the EUT to a position which is 0,1 nautical miles inside the defined geographical boundary of \*\*\*21.1.7. Check that the EUT now operates on channels Ch3A and receives on Ch3B

Change the geographical position of the EUT to a position which is 4,9 nautical miles from the final geographical boundary of \*\*\*21.1.7. Check that the EUT now operates on channels Ch3A and AIS1.

Change the geographical position of the EUT to a position which is 0,1 nautical miles beyond the defined geographical boundary of \*\*\*21.1.7. Check that the EUT now operates on channels AIS1 and AIS2.

## **20.2 (7.2) Scheduling**

Check that the time sequence of the TDMA messages is not changed when the EUT transmits a DSC signal.

Send a valid geographical call to the EUT. Check that the response is transmitted after a random delay distributed over the range of 0 to 20 s and subject to the restrictions of \*\*\*7.2.1.

Send a valid geographical call to the EUT followed by a signal consisting of dot pattern with a signal level of 0 dBµV EMF at the receiver input of 25 s duration. Check that the response is not transmitted until the dot pattern signal is terminated.

## **20.3 (7.3) Polling**

Check that the EUT is capable of receiving, processing and automatically transmitting a response to the following calls from ITU-R M.825: 101 (command to duplex-channel), 102, 103, 108, 109, 111, 112, and 116. The sequence of calls consisting of test signals number 1 and valid geographic calls shall demonstrate the capability of the EUT to operate on single frequency channels as well as on two frequency channels.

Check by decoding a standard test signal number 1 with additional symbol number 108 that ships maritime mobile service identify (MMSI), ship name, ships length and type of ship is programmed into the EUT.

Send a standard test signal number 1 with additional symbols number 109 and 116 and check that the reply messages 100, 119 and 120 are programmed automatically.

Check that when information is not available to respond to a command the transmitted response is followed by the symbol 126.

Send a standard test signal number 1 with additional symbol 101 followed by channel number 87. Repeat the test with channel number 88 and with symbol 104 and 00 followed by channel number 2087 and 2088. Check in all cases that the response is made on channel 70.

Send a DSI sentence to ports 4 and 5 with an individual station address and with command sets 103 (report your position) and 111 (report ship name). Check that the EUT does not transmit a DSC message.

## **21 Long Range functionality tests**

### **21.1 LR interrogation**

#### **Method of measurement:**

Operate standard test environment and EUT in autonomous mode. Apply a LR addressed interrogation message to the LR-interface port of EUT; Record LR output port. Set EUT to

- a) automatic response
- b) manual response

#### **Required results:**

Check that EUT outputs a LR position report message

- a) automatically (and indicates action on display)
- b) after manual confirmation

### **21.2 LR "all ships" interrogation**

#### **Method of measurement:**

Operate standard test environment and EUT in autonomous mode. Apply a LR "all ships" interrogation message to the LR-interface port of EUT defining a geographical area which contains own ships position; Record LR output port. Set EUT to:

- a) automatic response
- b) manual response.

Repeat check with own ship outside specified area

#### **Required results:**

Check that EUT outputs a LR position report message

- a) automatically (and indicates action on display)
- b) after manual confirmation.

No response shall be output on the repeat check.

## **Annex A Glossary of relevant ITU related terms**



## Annex B Normative Alarm and message transfer on IEC 61162-2/3 interfaces

### B.1 General

This annex defines formatters and methods to be used for alarms, indications and associated user information in case the UAIS uses the display surfaces of the IEC 61174 ECDIS or IEC 60936-3 radar with chart facilities.

Detailed information is given on IEC 61162-1/2 formatters and methods. For interfaces compliant with IEC 61162-3 nothing is specified as this standard is still in the drafting process.

Corresponding amendments will be done later.

### B.2 Formatters

The following approved sentences shall be used.

\$AIALR,..... for alarm/indication (output)

\$AIACK, ..... for acknowledgement (input) of the corresponding alarm as defined by the alarm ID number

\$AITXT, .....for additional associated text if the text field provided in \$AIALR, ... is not sufficient. The alarm ID number shall be used as text identifier

### B.3 Alarm numbers (identifiers)

The alarm numbers given in the table below are defined for the use with formatters as given in clause 2.

**Table X**

Failure description	Alarm number	Remarks
Undefined	00	Reserved for tests
One or more power supplies defective	01	
Tx synthesiser not locked	02	
UTC clock lost	03	
Tx power too low	04	
Tx too long on the air (disabled now)	05	
Tx failure (no output power)	06	
Antenna VSWR exceeds limit	07	
Rx channel AIS 1 malfunction	08	
Rx channel AIS 2 malfunction	09	
Rx channel 70 malfunction	10	
External positions lost/invalid	21	
Using fall-back position (GNSS module)	22	
No position available	23	
Speed over ground lost/invalid	24	
Course over ground lost/invalid	25	
Heading lost/invalid	26	
Rate of turn lost/invalid	27	

GNSS module status wrong	41	
Program memory (checksum)	42	If transmission is possible
Stored variable data (checksum)	43	
CPU/program failure	49	If transmission is possible

Additional numbers may be used by the manufacturers for other purposes but shall be in the range 51 – 99. Higher numbers in the range 100 – 999 shall not be used as they do not allow the application of additional information formatters as "\$AITXT,.....".

#### B.4 Repetition of alarm messages

Alarm and indication messages (output) shall be sent immediately after any status or contents change and repetitively after every 30 s latest.

For the status of "NO ALARM" after every 30 s (latest) an empty alarm message shall be transmitted by the AIS. This message does not contain any information between the comma delimiters and does only prove that the system and its interface is in operation.

The message shall be formatted as shown below:

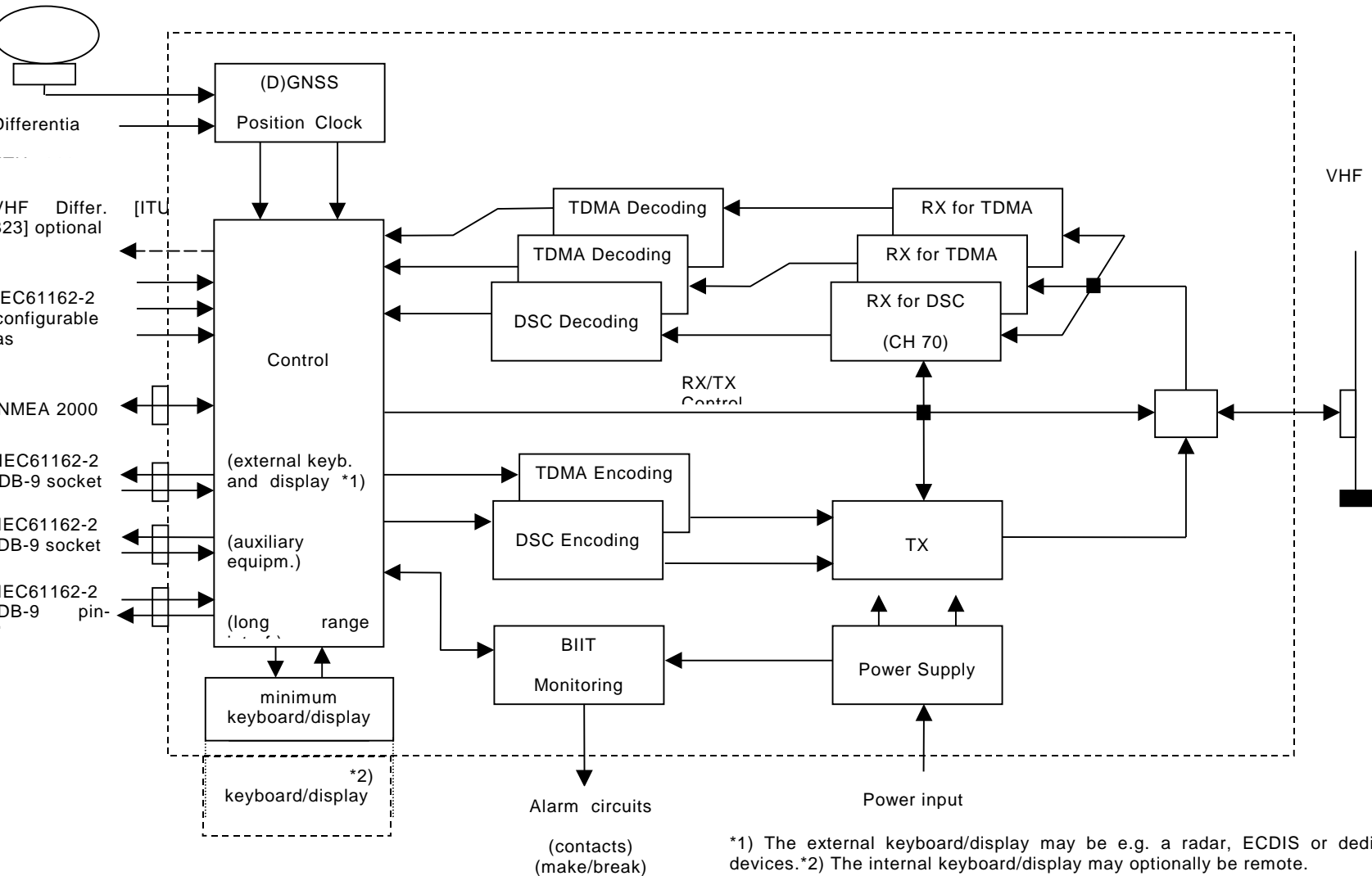
\$AIALR,,,,,\*hh<CR><LF>

When any alarm condition is present and other complete \$AIALR, --- messages are output this empty alarm message shall be omitted.]

### **Annex C Normative: Specification of AIS symbols to be used.**

List of symbols to be used for the 'primary information set' including size, shape and colour will be those contained in IEC 61174 Ed 2 Annex E.

Annex D informative Block Diagram of AIS



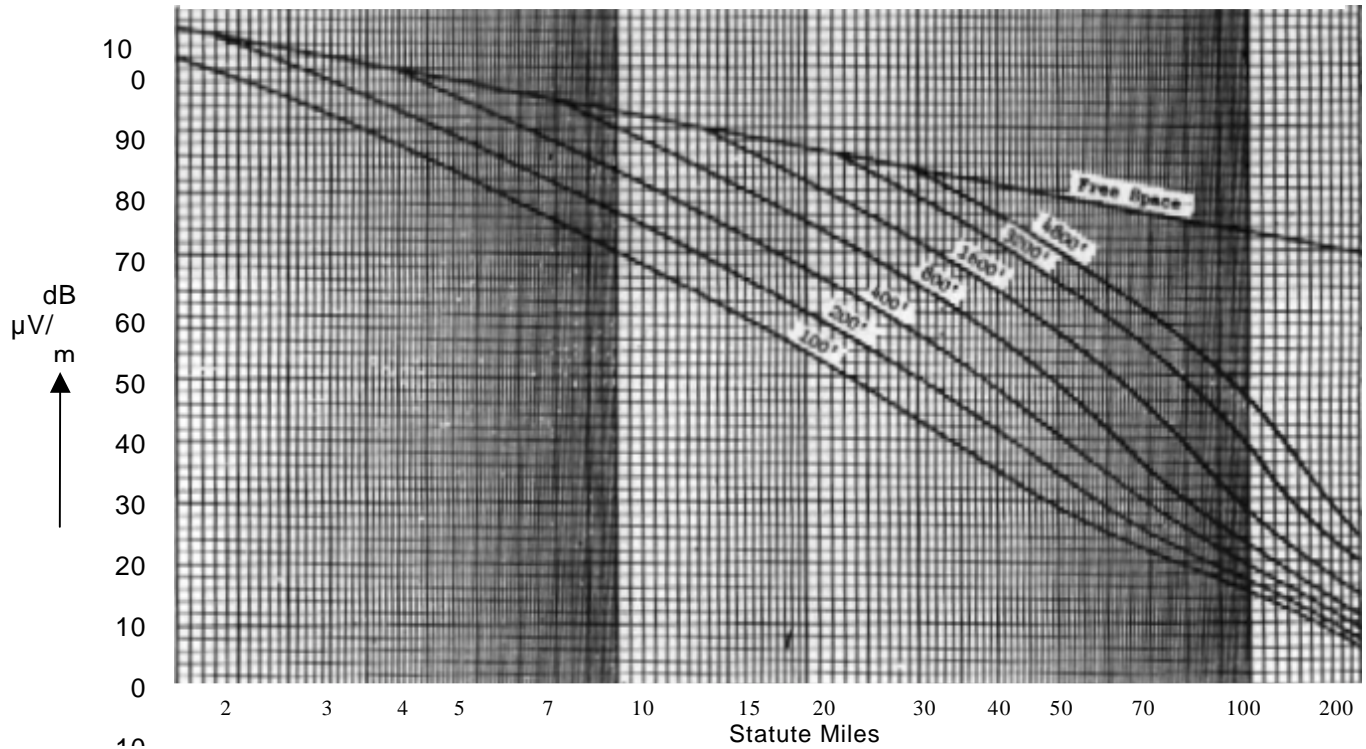
\*1) The external keyboard/display may be e.g. a radar, ECDIS or dedicated devices.  
\*2) The internal keyboard/display may optionally be external. [Functionality t.b.d. !]

## Annex E Informative AIS coverage range

(Reference: FCC Handbook 47 CFR 80.769, Standard method)

### E.1 F<sub>1</sub> Seawater Propagation Curve for the VHF Maritime Mobile Radio Service

Field Strengths in dB $\mu$ V/m for an Effective Radiated Power of 1 kW  
 Vessel Antenna Height = 30 ft. (9 meters)  
 Coast Station Antenna Heights: 4800, 3200, 1600, 800, 400, 200, 100 ft.



Power output: + 41 dBm (12.5 watts, -19 dBKW)

Feed line losses: -2 dB

Radio tower antenna elevation: 100 meters (328 ft.) ASL

Antenna gain: + 6 dBA (dipole referenced, elements rotated toward tower)

Ship station receiver sensitivity: -107 dBm (0 dB $\mu$ V emf, IEC VHF spec.)

Ship station antenna placement: 9 meters above waterline

Link margin: 12 dBL (for antenna placement and sea state)

Adjustments to seawater propagation curves in 80.767:

- use 328 ft. curve (interpolate between 200ft. and 400ft. curves)
- ref. vertical axis +27 dB (19 dBKW – 6 dBA + 2 dB + 12 dBL)
- 328 ft. curve intersects +27 dB line at 52 statute miles
- multiply statute miles by 0.869 to get **45 nautical miles**

This analysis is for the shore-ship link, but the value of RF power was selected to match the AIS transponder's nominal high power setting (12.5 watts) so that the same analysis could also represent the ship-shore link.

### E.2 SHIP-SHIP OPERATIONS:

Power output: + 41 dBm (12.5 watts, -19 dBKW)

Feed line losses: -2 dBF

Reference antenna elevation: 9 meters ASL

Antenna gain: + 0 dBA (dipole referenced, ship's antenna)

Ship station receiver sensitivity: -107 dBm (0 dBµV emf, IEC VHF spec.)

Ship station antenna placement: 9 meters above waterline

Link margin: 12 dBL (for antenna placement and sea state)

Adjustments to seawater propagation curves in 80.767:

- adjust reference antenna height to -10 dBH (20 log (30/100))
- ref. vertical axis +43 dB (19 dBKW +10 dBH + 2 dBF + 12 dBL)
- 100 ft. curve intersects +43 dB line at 21 statute miles
- multiply statute miles by 0.869 to get **18 nautical miles**

### **E.3 Adjustments for power and receiver sensitivity (ship-ship)**

For low power setting on transponder:

- for low power setting (+ 33 dBm, 2 watts, - 27 dBKW):
- ref. vertical axis +51 dB (+43 dB + 10 log (2/12.5))
- 100 ft. curve intersects +51 dB line at 15 statute miles
- multiply statute miles by 0.869 to get 13 nautical miles

For compromised receiver sensitivity:

- for compromised receiver sensitivity: -101 dBm (+6 dBµV emf.)
- ref. vertical axis +49 dB (+43 dB +6 dBµV)
- 100 ft. curve intersects +49 dB line at 16 statute miles
- multiply statute miles by 0.869 to get 14 nautical miles

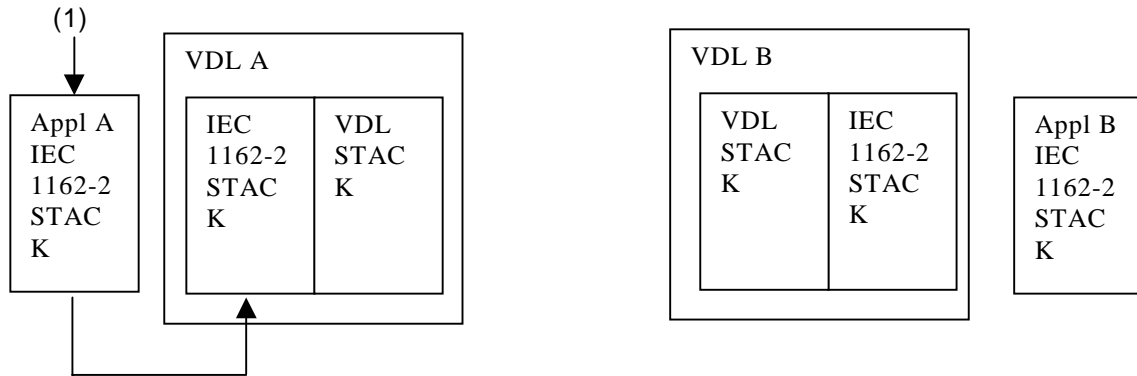
For low power and compromised receiver sensitivity:

- for compromised receiver sensitivity and low power:
- ref. vertical axis +57 dB (+51 dB +6 dBµV)
- 100 ft. curve intersects +57 dB line at 11.5 statute miles
- multiply statute miles by 0.869 to get 10 nautical miles

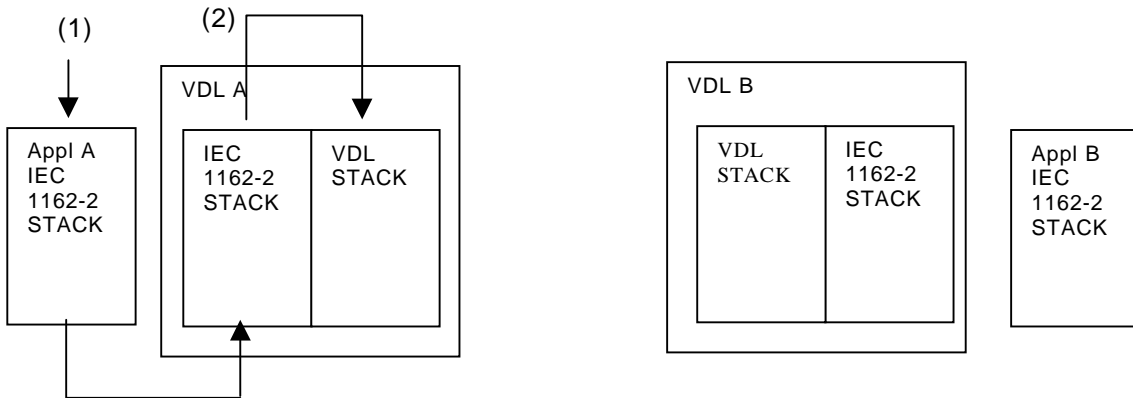
Note that a 12 dB link margin has been assumed in all these calculations. The 2 watt power setting is analysed because some ships may need to protect their VHF radios from interference from the AIS transponder by reducing the transponder power. The reduced receiver sensitivity is analysed because the AIS transponder may experience intermodulation interference from other VHF radios.

## Annex F Informative Sequencing of transmission packets

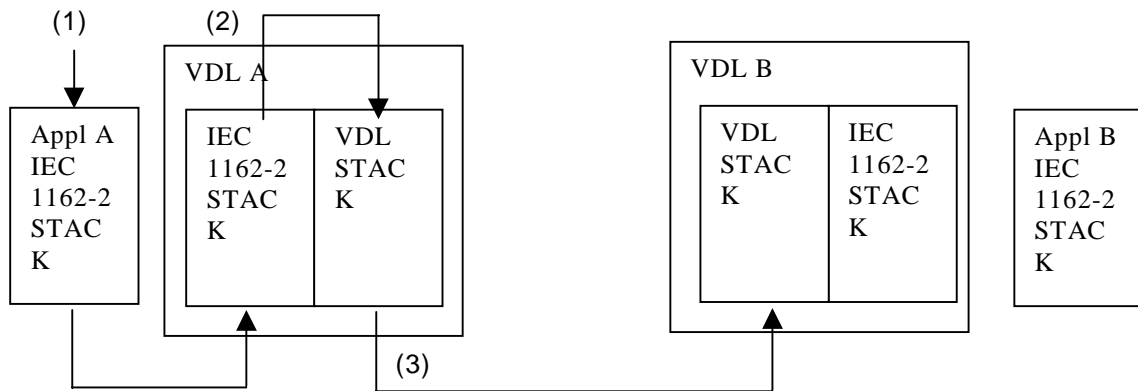
The originating application assigns a sequence number to each transmission packet, using the ABM message. The sequence number can be 0, 1, 2 or 3. This number together with message type and destination gives the transmission a unique *transaction identifier*. This transaction identifier is communicated to the receiving application.



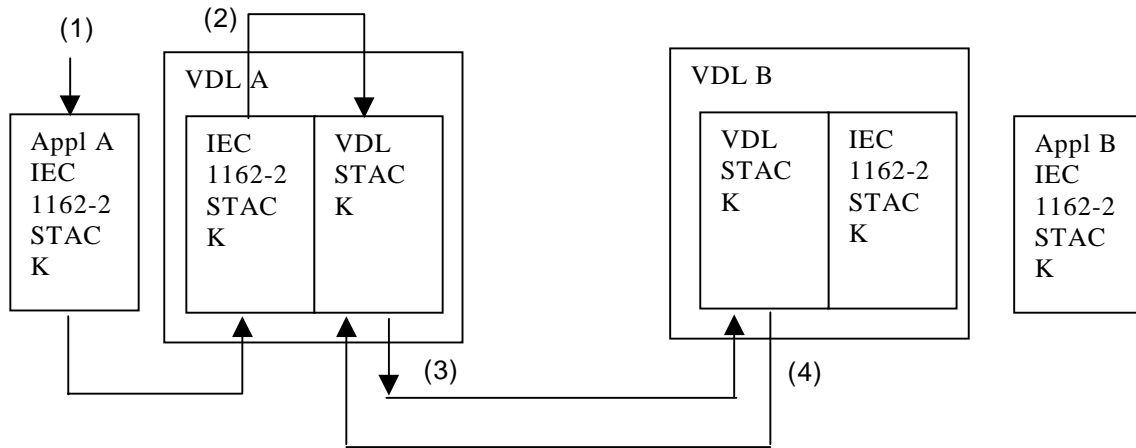
1. Application A delivers 4 ABM messages addressed to B with sequence numbers 0, 1, 2 and 3.



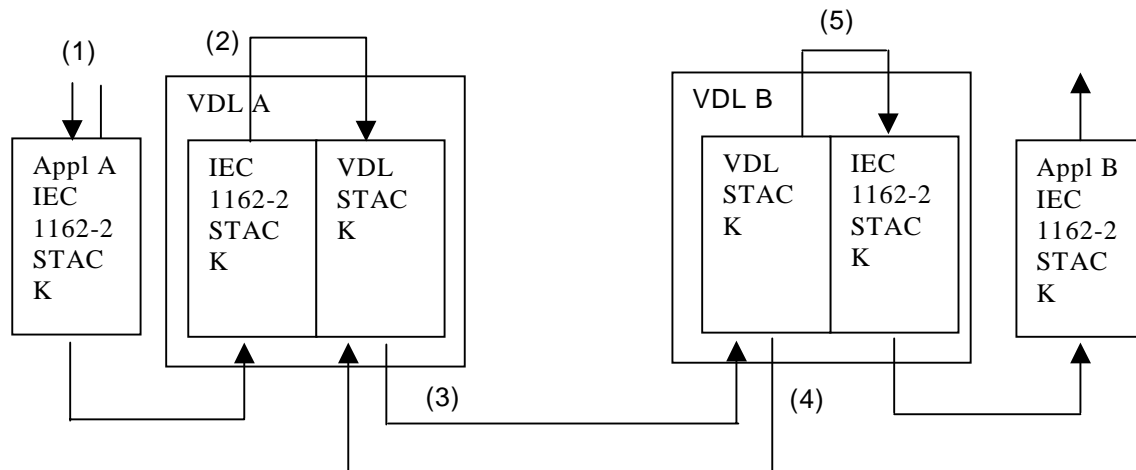
2. VDL-A receives ABM messages and puts them in the transmit queue.



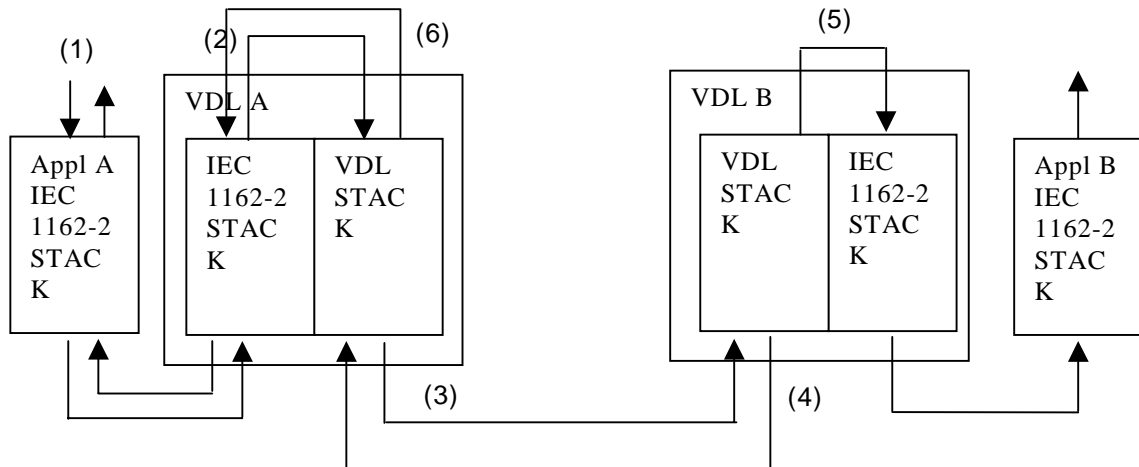
3. VDL-A transmits the messages to VDL-B, which only receives messages with sequence number 0 and 3.



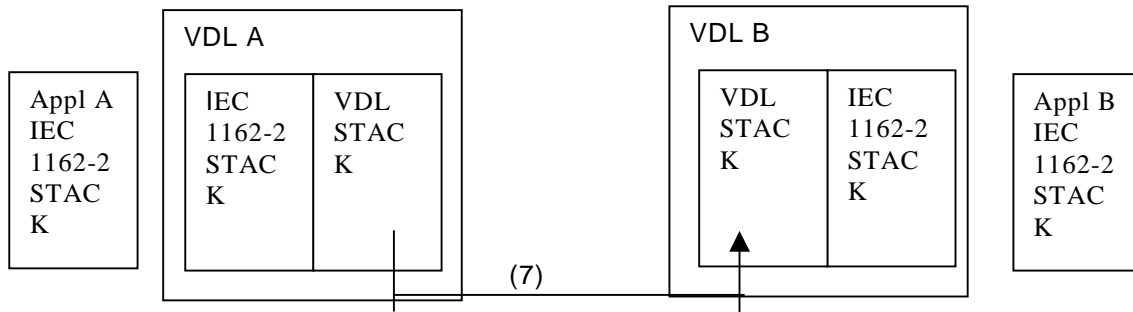
4. VDL-B returns VDL-ACK messages with sequence numbers 0 and 3 to VDL-A.



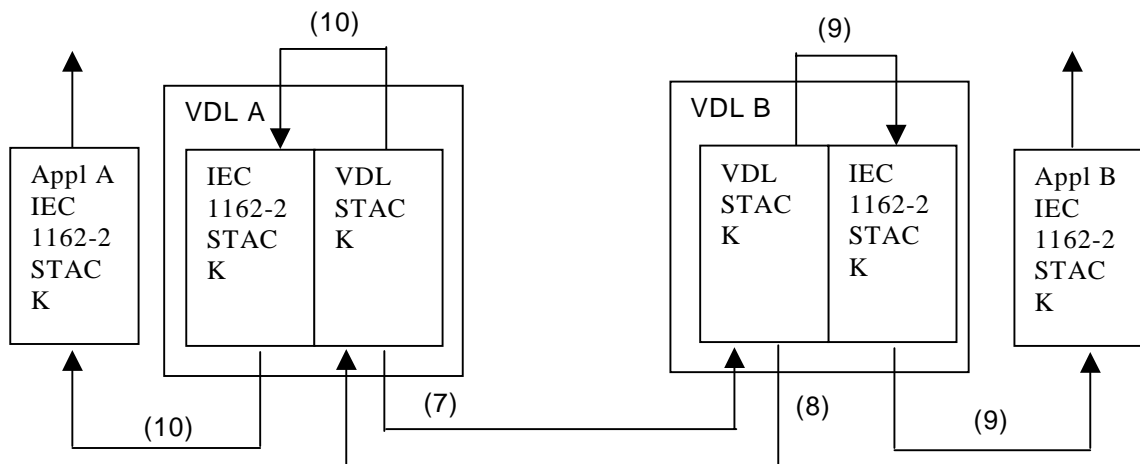
5. VDL-B delivers ABM messages with sequence number 0 and 3 to application B.



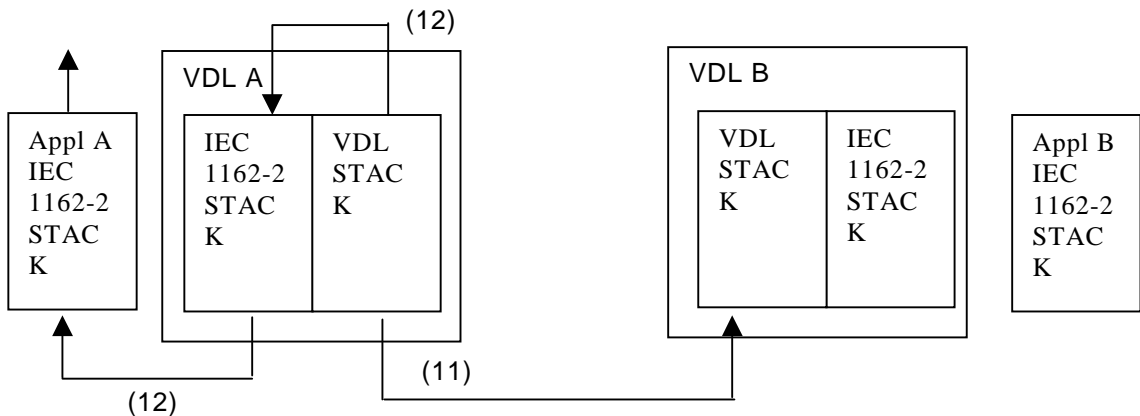
6. VDL-A returns PI-ACK (OK) to application A with sequence numbers 0 and 3.



7. VDL-A times out on sequence numbers 1 + 2 and retransmits the addressed messages to VDL-B.



8. VDL-B successfully receives message 2 and returns a VDL-ACK with sequence number 2.  
 9. VDL-B delivers ABM message with sequence number 2 to application B.  
 10. VDL-A delivers PI-ACK(OK) with sequence number 2 to application A.



11. VDL-A retransmits message, with sequence number 1, but does not receive a VDL-ACK from VDL-B. It does this two times and is unsuccessful in delivering the message.  
 12. VDL-A, upon failing the transmit transaction of message with sequence number 1, delivers a PI-ACK(FAIL) to application A.

## Annex G Informative New messages of IEC 61162 due to AIS

### G.1 Serial messages overview

#### Serial output messages related to received VDL messages

##### **AIS target display information**

- 1,2,3 position report
- 4 base station report
- 5 voyage related data

##### **safety message handling**

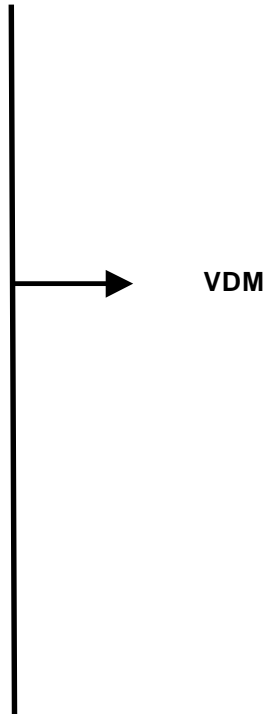
- 12 addressed safety related
- 14 broadcast safety related

##### **ext. Application handling**

- 6 binary addressed
- 8 binary broadcast
- 9 periodical alternate
- 19 VTS targets

##### **System control**

- 7 binary acknowledge (INFO)
- 13 safety related ack (INFO)
- 15 interrogation (INFO)
- 21 proprietary
- 22 channel management (INFO)



#### Serial output messages related to broadcast VDL messages

VHF Data-link messages broadcast by **VDO**

shipborne AIS unit (1, 2, 3, 5, 6, 7, 8, 10,  
11, 12, 13, 14, 15, 21)

Addressed binary acknowledgement **ABK**

#### Serial output messages NOT directly related to VDL messages

Long Range response **LR1, LR2, LR3**

alarm status *ALR, TXT [existing]*

#### Serial input messages directly related to VDL messages

6 addressed binary **ABM**

5 ship and voyage related data **SSD, VSD**

8 broadcast binary **BBM**

12 addressed safety related **ABM**

14 broadcast safety related **BBM**

15 AIS interrogation request **AIR**

16 broadcast test/evaluation **BBM**

#### Serial input messages NOT directly related to VDL messages

AIS alarm ack. **ACK** [existing]

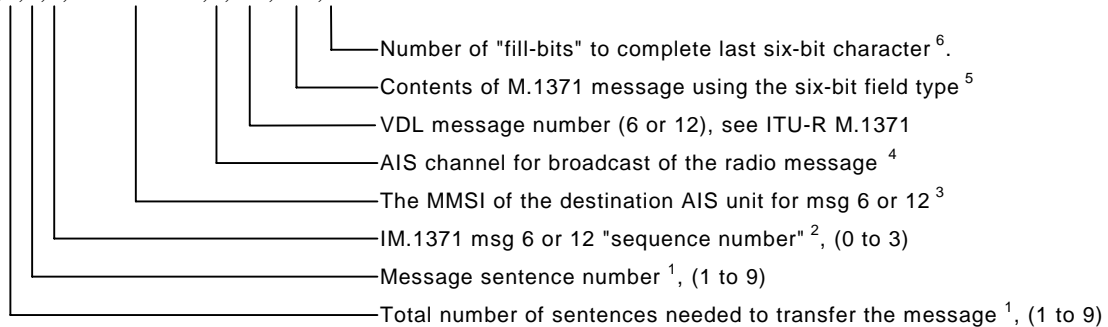
Long Range interrogation **LRI, LRF**

## G.2 PROPOSED IEC 61162-1 AIS SENTENCES

### G.2.1 ABM - Addressed Binary and safety related Message

This sentence supports ITU-R M.1371 messages 6 and 12. It provides an external application with a means to exchange data using an AIS transponder. Data defined by the application only - not the AIS unit. This message offers great flexibility for implementing system functions that use the transponder like a communications device. After receiving this sentence, the AIS transponder initiates a radio broadcast (on the VHF Data Link) of either message 6 or 12. The AIS unit will make up to four broadcasts of the message. The actual number will depend on the reception of an acknowledgement from the addressed "destination" AIS unit. The default time between retries is four seconds. Retries will not be attempted more frequently than 4 seconds. Retries end upon reception of the appropriate acknowledgement (see ITU-R M.1371 messages 7 and 13). The AIS unit will use up to 4 broadcasts, original broadcast plus three retries, to obtain an acknowledgement. This process could take up 32 seconds to complete. The result of these broadcasts is provided by the ABK-sentence. The success or failure of reception of this broadcast by the intended AIS unit is confirmed through the use of the "Addressed and binary broadcast Acknowledgement (ABK)" sentence formatter, and the processes that support the generation of an ABK-sentence.

!--ABM,x,x,x,xxxxxxxx,x,x,x,s--s,x\*hh<CR><LF>



NOTE 1 The total number of sentences required to transfer the binary message data to the AIS unit. The first field specifies the total number of sentences used for a message, minimum value 1. The second field identifies the order of this sentence in the message, minimum value 1. All sentences contain the same number of fields. Successive sentences may use null fields for fields that have not changed (fields 4, 5, and 6).

NOTE 2 The sequence number (a value of 0, 1, 2, or 3) serves two purposes. It satisfies the requirements of Section 5.3.3 (a new proposed section in 61162-1), and it is utilized by the ITU-R M.1371 in message types 6 or 12. The sequence number and the destination MMSI uniquely identifies a message. The sequence number for a message to a particular MMSI may be reused after the "ABK" acknowledgement for that sequence number is provided by the AIS unit. (also reference the ABK-sentence formatter)

NOTE 3 The MMSI of the AIS unit which is the destination of the message.

NOTE 4 The AIS channel that shall be used for the broadcast: 0 = no broadcast channel preference, 1 = Broadcast on AIS channel 1, 2 = Broadcast on AIS channel 2, 3 = Broadcast two copies of the message - one on each channel.

NOTE 5 This is the content of the "binary data" parameter for ITU-R M.1371 messages 6, or the "Safety related Text" parameter for message 12. Up to 936 bits of binary data (156, six-bit symbols) using multi-line sentences. The first sentence may contain up to 48 symbols (288 bits). The following sentences may contain up to 60 symbols (360 bits), if fields 4, 5, and 6 are unchanged from the first sentence and set to null. The actual number of symbols must be such that the total number of characters in a sentence does not exceed the "82-character" limit.

NOTE 6 Each character in the preceding six-bit coded character string represents six binary bits. This parameter indicates the number of bits that were added to the end of the binary packet as a result of creating the last character of the string. When the coding of the last six-bit character of the message packet does not create additional "fill-bits," this value shall be set to zero. The value "0" indicates that no "fill-bits" were added. This field shall not be null.

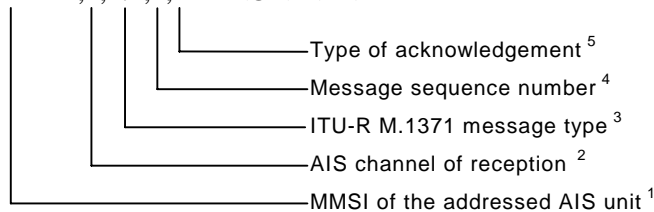
### G.2.2 ABK - Addressed and binary broadcast acknowledgement

The ABK-sentence is generated when a transaction, initiated by reception of an ABM, ACA, AIR, or BBM sentence, is terminated.

For the ABM-sentence, the ABK-sentence provides information about the success or failure of the requested ABM broadcast of either ITU-R M.1371 messages 6 or 12. The ABK process utilizes the information received in ITU-R M.1371 messages 7 and 13. Upon reception of either a VHF Data-link message 7 or 13, or the failure of messages 6 or 12, the AIS unit delivers the ABK sentence to the external application.

For the ACA, AIR, and BBM sentences, the ABK sentence is used to report to the external application the AIS unit's handling of the ACA (M.1371 message 22), AIR (M.1371 message 15) and BBM (M.1371 messages 8, 14, 19, and 21) sentences. The external application initiates an interrogation through the use of the AIR-sentence, or a broadcast through the use of the ACA and BBM sentences. The AIS unit generates an ABK sentence to report the outcome of the ACA, AIR, or BBM broadcast process.

\$AIABK,xxxxxxxx,x,x,x,x,x\*hh<CR><LF>



NOTE 1 Identifies the distant addressed AIS unit involved with the acknowledgement. If more than one MMSI are being addressed (M.1371 messages 15 and 16), the MMSI of the first distant AIS unit, identified in the message, is the MMSI reported here. When the message type is 8 or 14, this field is null.

NOTE 2 Indication of VDL channel upon which message type 7 or 13 acknowledgement was received. A "1" indicates reception on channel 1. A "2" indicates reception on channel 2. If not available, field is null.

NOTE 3 This indicates to the external application the type of M.1371 message that this ABK sentence is addressing. Also see the message types listed in NOTE 4.

NOTE 4 The message sequence number, together with the M.1371 message type and MMSI of the addressed AIS unit, uniquely identifies a previously received ABM, ACA, AIR, or BBM sentence. Generation of an ABK-sentence makes a sequence number available for reuse. The message type determines the source of the sequence number. The following table lists the source by message type:

Message Type	Sequence Number source
6	message sequential identifier from ABM-sentence, IEC 61162-1
7	addressed AIS unit's message 7, sequence number, ITU-R M.1371
8	message sequential identifier from BBM-sentence, IEC 61162-1
12	message sequential identifier from ABM-sentence, IEC 61162-1
13	addressed AIS unit's message 13, sequence number, ITU-R M.1371
14	message sequential identifier from BBM-sentence, IEC 61162-1
15	no source, field shall be null
16	no source, field shall be null
19	message sequential identifier from BBM-sentence, IEC 61162-1
20	no source, field shall be null
21	message sequential identifier from BBM-sentence, IEC 61162-1
22	no source, field shall be null

NOTE 5 Acknowledgements provided are:

- 0 = message (6 or 12) successfully received by the addressed AIS unit,
- 1 = message (6 or 12) was broadcast, but no acknowledgement by the addressed AIS unit,
- 2 = message could not be broadcast,
- 3 = requested broadcast of message (8, 14, 15, 16, 19, 20, 21, or 22) has been successfully completed,
- 4 = late reception of a message 7 or 13 acknowledgement "addressed to own-ship" MMSI - identified by; destination MMSI, acknowledgement source MMSI, sequence number, and message type.

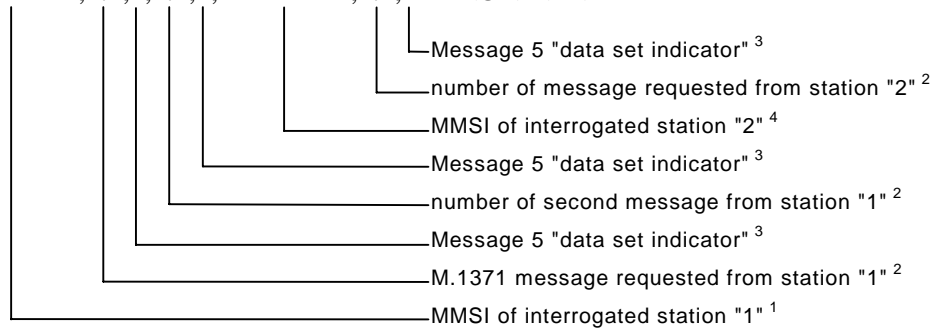
### G.2.3 AIR - AIS Interrogation Request

This sentence supports ITU-R M.1371 message 15. It provides an external application with the means to initiate a request for specific ITU-R M.1371 messages from distant mobile or base station AIS units. A single sentence can be used to request up to two messages from one AIS unit and one message from a second AIS unit. The message types that can be requested are limited. An interrogation directed to a distant mobile AIS unit can request only messages 3 and 5. An interrogation directed to a distant base station can request only messages 4, 17, 20, and 22. Improper requests for messages may be ignored by the interrogated AIS unit.

The external application initiates the interrogation. The external application is responsible for assessing the success or failure of the interrogation. After receiving this sentence, the AIS transponder initiates a radio broadcast (on the VHF Data Link) of a message 15 - Interrogation.

The success or failure of the interrogation broadcast is determined by the application through the content of the ABK-sentence and future VDM-sentences provided by the AIS unit. After receiving this AIR-sentence, the AIS unit shall take no more than four seconds to broadcast the message 15, and the addressed distant unit(s) shall take no more than another four seconds to respond - a total of eight seconds.

\$--AIR,xxxxxxxx,x.x,x.x,x.x,xxxxxxxx,x.x,x\*hh<CR><LF>



NOTE 1 Identifies the first distant AIS unit being interrogated. Two messages can be requested from the first AIS unit.

NOTE 2 The message numbers (3, 4, 5, 17, 20, and 22) are based upon ITU-R M.1371.

The following messages may be requested from a distant mobile AIS unit:

Message 3, Position Report,  
Message 5, Ship Static and Voyage related data. This has 4 separate message subsets. See note 3.

The following messages may be requested from a distant AIS base station.

Message 4, Base Station Report  
Message 17, GNSS Broadcast Binary Message, differential GNSS corrections based upon ITU-R M.823-2  
Message 20, Data Link Management Message  
Message 22, Channel Management

NOTE 3 Message 5 is sub-divided into four major sections. Each of these sub-divisions define the bits in the VDL packet differently. When requesting message 5 information, the "Data Set Indicator" must be provided, so that the correct sub-division of data is provided. If message 5 is not being requested, this field can be null. The "Data Set Indicators" for the four sub-divisions are:

- 0 = Ship Static and Voyage Related Data, used only by a mobile station,
- 1 = Extended Ship Static and Voyage Related Data, used only by a mobile station,
- 2 = Aids-to-Navigation Data, used only by AIS units mounted on aids-to-navigation, and
- 3 = Regional Ship Static and Voyage Related Data, used by a mobile station for regional purposes.

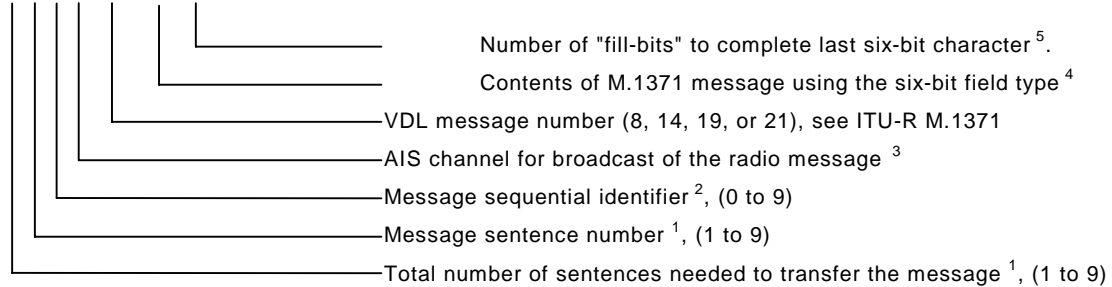
NOTE 4 This identifies the second distant AIS unit being interrogated. Only one message may be requested from the second AIS unit. The MMSI of the second AIS unit may be the same MMSI as the first AIS unit.

NOTE 5 Unused fields shall be left null.

## G.2.4 BBM - Broadcast Binary Message

This sentence supports generation of ITU-R M.1371 binary messages, 8, 14, 19, and 21. It provides the application with a means to broadcast data, as defined by the application only - not the AIS unit. This message offers great flexibility for implementing system functions that use the transponder like a digital broadcast device. After receiving this sentence, the AIS transponder initiates a radio broadcast (on the VHF Data Link) of either message 8, 14, 19, or 21 within four seconds. (Also see the ABK-sentence.)

!--BBM,x,x,x,x,x,x,s--s,x\*hh<CR><LF>



NOTE 1 The total number of sentences required to transfer the contents of the binary message to the AIS unit. The first field specifies the total number of sentences used for a message, minimum value 1. The second field identifies the order of this sentence in the message, minimum value 1. All sentences contain the same number of fields. Successive sentences may use null fields for fields that do not change - such as fields 4 and 5.

NOTE 2 The "message sequential identifier" is a number from 0 to 9 that is sequentially assigned as needed. This identifier is incremented for each new multi-sentence message. The count resets to 0, after 9 is used. For radio broadcast messages requiring multiple sentences, each sentence of the message contains the same sequential identification number. The purpose of this number is to link the separate sentences containing portions of the same radio message. This allows for the possibility that other sentences might be interleaved with the message sentences that contain the complete message contents. This number also links an ABK-sentence acknowledgement to the appropriate BBM-sentence.

NOTE 3 The AIS channel that shall be used for the broadcast: 0 = no broadcast channel preference, 1 = Broadcast on AIS channel 1, 2 = Broadcast on AIS channel 2, 3 = Broadcast two copies of the message - one on each channel.

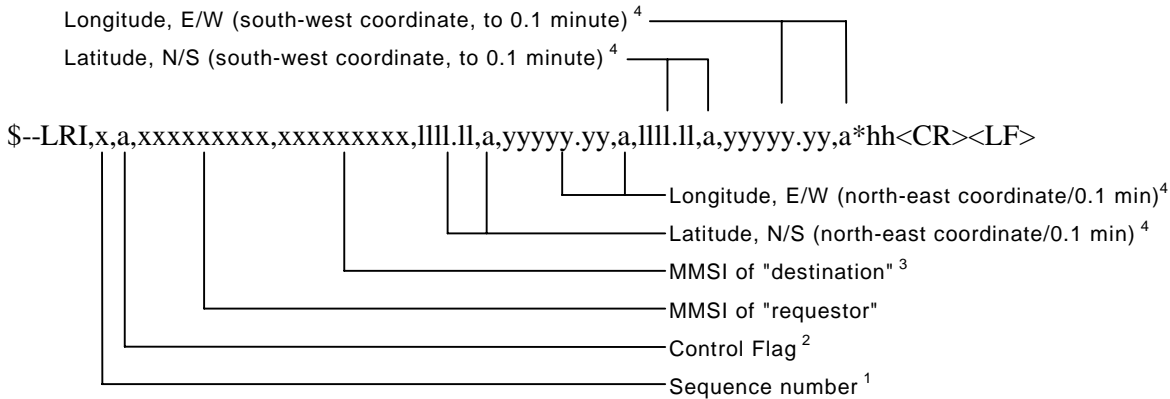
NOTE 4 This is the content of the "binary data" parameter for ITU-R M.1371 messages 8, 19, and 21, or the "Safety related Text" parameter for message 14. Up to 968 bits of binary data (162, six-bit symbols) using multi-line sentences. The first sentence may contain up to 55 symbols (330 bits). The following sentences may contain up to 59 symbols (354 bits), if fields 4, 5, and 6 are null. The actual number of symbols must be adjusted so that the total number of characters in a sentence does not exceed the "82-character" limit.

NOTE 5 Each character in the preceding six-bit coded character string represents six binary bits. This parameter indicates the number of bits that were added to the end of the binary packet as a result of creating the last character of the string. When the coding of the last six-bit character of the message packet does not create additional "fill-bits," this value shall be set to zero. The value "0" indicates that no "fill-bits" were added.

## G.2.5 LRI and LRF - Long-range Interrogation (sentence pair)

### G.2.5.1 LRI - Long-range Interrogation

The Long-range interrogation of the AIS unit is accomplished through the use of two sentences. The pair of interrogation sentence formatters, "LRI" followed by "LRF," provides the information needed by a universal AIS unit to determine if it must construct and provide the reply sentences (LR1, LR2, and LR3). The "LRI" sentence contains the information that the AIS unit needs in order to determine if the reply sentences need to be constructed. The "LRF" sentence identifies the information that needs to be in those reply sentences.



NOTE 1 This is a number, 0 to 9, that is used to bind the contents of the LRI and LRF sentences together. Under routine conditions, the LRF sentence shall immediately follow the LRI sentence and use the same sequence number. The requestor process shall increment the sequence number each time a LRI/LRF pair is created. The sequencing process shall continuously increment. After 9 is used the process shall begin again from 0.

NOTE 2 The control flag is a single character that qualifies the request for information. The control flag affects AIS unit's reply logic. The control flag cannot be a null field.

When the Control Flag is "0", the logic is normal. Under "normal" operation, the AIS unit responds under the following conditions:

- The AIS unit is within the geographic rectangle provided, **and**
- The AIS unit has not responded to the requesting MMSI in the last 24 hours, **and**
- The MMSI "destination" field is null.

or

- The AIS unit's MMSI appears in the MMSI "destination" field in the LRI sentence.

When the Control Flag is "1", the AIS unit responds under the following condition:

- The AIS unit is within the geographic rectangle provided.

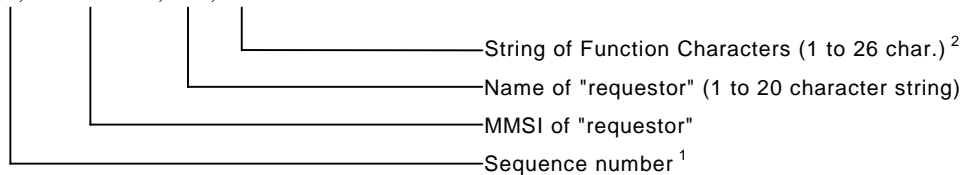
NOTE 3 This is the nine digit number that uniquely identifies the specific AIS unit that shall respond. This field is a null field when the interrogation is for a region. When addressing a specific AIS unit, it is not necessary to provide the geographic coordinates of the region.

NOTE 4 The geographic region being interrogated is a rectangle defined by the latitude and longitude of the north-east and south-west corners. These coordinates are provided to the tenth of a minute, using the ddmm.m convention shown in Table 6 of this standard. These fields shall be null when interrogating a specific AIS unit (see note 2).

### G.2.5.2 LRF - Long-Range Function

The second sentence of the Long-range interrogation pair is the "LRF" sentence. This sentence shall immediately follow a LRI sentence and contain the same sequence number. The fourth field, function identification character string, of this sentence contains a string of letters. These letters identify specific internationally agreed information as defined in IMO Resolution A.851(20). The letters in the function identification character string identify the information that shall be provided in the reply sentences (LR1, LR2, and LR3 sentence formatters).

\$--LRF,x,xxxxxxxx,c--c,c--c\*hh<CR><LF>



NOTE 1 This is a number, 0 to 9, that is used to bind the contents of the LRI and LRF sentences together. Under routine conditions, the LRF sentence shall immediately follow the LRI sentence and use the same sequence number. The requestor process shall increment the sequence number each time a LRI/LRF pair is created. The sequencing process shall continuously increment. After 9 is used the process shall begin again from 0. The reply sentences (LR1, LR2, and LR3) shall not be generated if this number does not match the previous LRI sequence number.

NOTE 2 The function identification character string uses alphabetic characters, defined in IMO Resolution A.851(20), to request specific information items. Specific information items are requested by including their function identification character in this string. The order in which the characters appear in the string is not important, but they shall be capitalized. Information items will not be provided if they are not specifically requested - even if available to the AIS unit. The IMO list uses all characters from A to Z. Not all of defined information is available to the AIS unit. The following is a list of the function identification characters, and the information item(s) they request, that are available to the AIS:

- A = Ship's: name, call sign, and IMO number
- B = Date and time of message composition
- C = Position
- E = Course over ground
- F = Speed over ground
- I = Destination and Estimated Time of Arrival (ETA)
- O = Draught
- P = Ship / Cargo
- U = Ship's: length, breadth, type
- W = Persons on board

## G.2.6 LR1, LR2, and LR3 - Long-range Reply

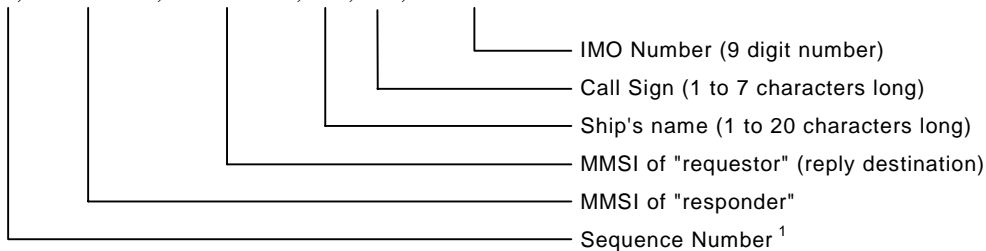
The Long-range reply of the AIS unit is accomplished through the use three sentences formatters (LR1, LR2, and LR3). The AIS unit shall reply with the three sentences, in the order LR1, LR2, and LR3, when responding to an interrogation - even if all the information items in the sentence are null. The LR1-sentence identifies the destination for the reply and contains the information items requested by the "A" function identification character in the "LRF" sentence - if requested. The LR2-sentence contains the information items requested by the "B, C, E, and F" function identification character in the "LRF" sentence - if requested. The "LR3" sentence contains the information items requested by the "I, O, P, and U" function identification character in the "LRF" sentence - if requested. Future expansion of the number of reply items would require definition of new sentences, such as LR4, LR5, etc.

The individual information items will be a null field if any of the following conditions exist:

- The information item was not requested,
- The information item was requested but is not available, or
- The information item was requested but is not being provided.

### G.2.6.1 LR1 - destination for reply and "A" requested itmes

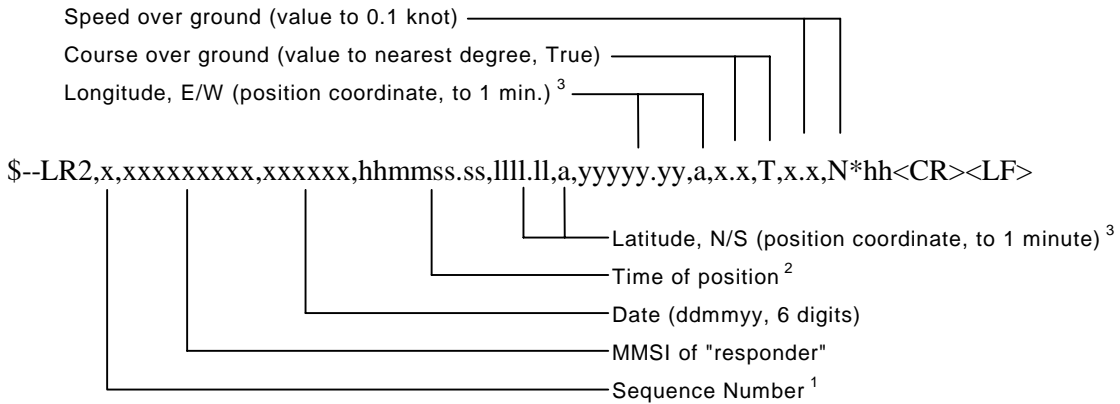
\$--LR1,x,xxxxxxxx,xxxxxxxx,c--c,c--c,xxxxxxxx\*hh<CR><LF>



NOTE 1 The sequence number should be the same number as the sequence number of the LRI and LRF sentences that initiated this reply.

NOTE 2 This sentence formatter shall be implemented to respond to an IEC 61162-1 query sentence.

### G.2.6.2 LR2 - "B, C, E, and F" requested items



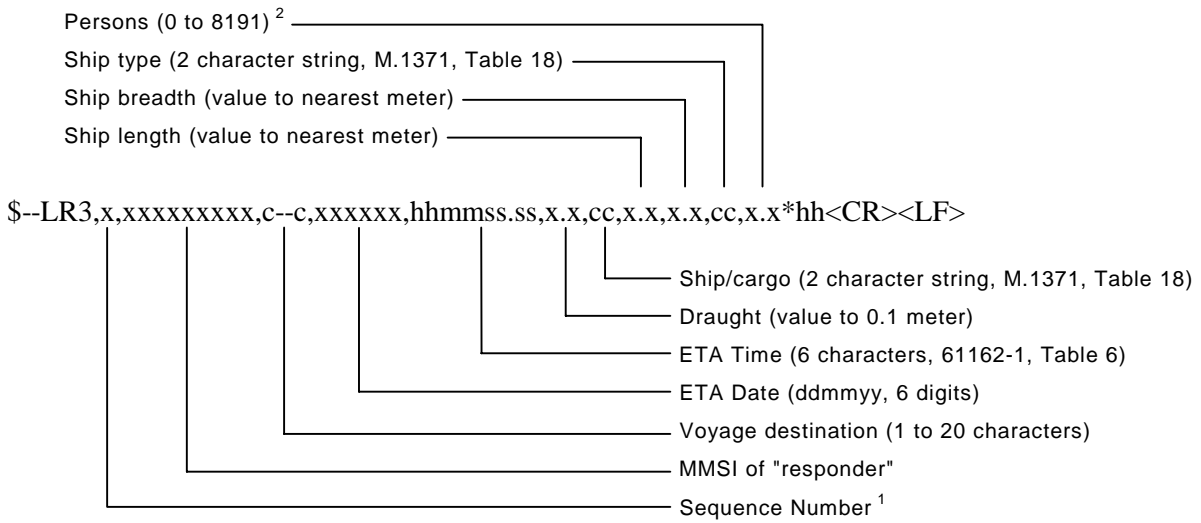
NOTE 1 The sequence number should be the same as the sequence number of the LRI and LRF sentences that initiated this reply.

NOTE 2 Time of the position calculation given to the nearest second (6 characters, see format information in IEC 61162-1, Table 6).

NOTE 3 The latitude and longitude information items shall be rounded to the nearest minute. The format of the items shall follow the convention shown in 61162-1, Table 6 (latitude = ddmm, and longitude = dddmm).

NOTE 4 This sentence formatter shall be implemented to respond to an IEC 61162-1 query sentence.

### G.2.6.3 LR3 - "I, O, P, U and W" requested items



NOTE 1 The sequence number should be the same as the sequence number of the LRI and LRF sentences that initiated this reply.

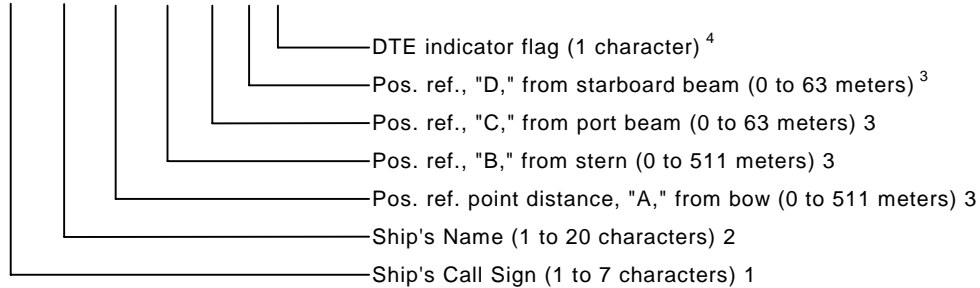
NOTE 2 Current number of persons on-board, including crew members: 0 to 8191. 0 = default (not available), 8191 = 8191 or more people.

NOTE 3 This sentence formatter shall be implemented to respond to an IEC 61162-1 query sentence.

### G.2.7 SSD - Ship Static Data

This sentence is used to enter static parameters into a shipboard AIS unit. The parameters in this sentence support a number of the ITU-R M.1371 messages. The data contained in this sentence is used to broadcast information about where and how this shipboard AIS unit is installed. Information that does not change frequently. Portions of this information are use in ITU-R M.1371 messages; 1, 2, 3, 5, and 9.

\$--SSD,c--c,c--c,xxx,xxx,xx,xx,c\*hh<CR><LF>



NOTE 1 Ship call sign. A null field indicates that the previously entered call sign is unchanged. The string of characters "@ @ @ @ @ @ @" are used to indicate that the call sign is not available.

NOTE 2 Up to 20 characters naming the ship. The characters that can be used in the name are listed in Table 14 of ITU-R M.1371. Some of the acceptable characters in Table 14 are reserved characters under IEC 61162.1. They must be represented using the "^" method (see section X.X.X). A null field indicates that the previously entered name is unchanged. The string of characters "@ @" are used to indicate that the ship's name is not available.

NOTE 3 These are the four dimensions from the bow, stern, port beam, and starboard beam to the horizontal reference point on the ship for which the current "position reports" are valid. The sum of A + B is the length of the ship in meters, and the sum of C + D is the width of the ship in meters. Refer to Section 3.3.8.2.3.6 of ITU-R M.1371, "Reference Point for reported position and Dimensions of Ship." If the reference point of "reported position" is not available, but the dimensions of the ship are available: A = C = 0 and B > 0 and D > 0. If neither the reference point for the reported position nor the dimensions of the ship are available: A = B = C = D = 0 (default). Use of a null field for A, B, C, and/or D indicates that the previously entered dimension for that parameter is unchanged. In many cases, the ship's reference point for "reported position" will be the location of the GNSS antenna.

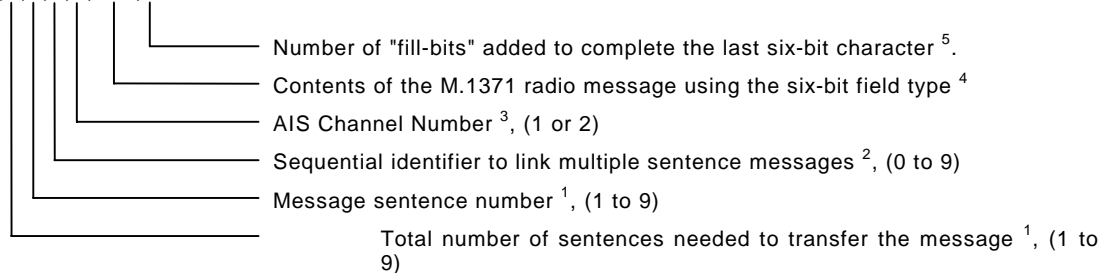
NOTE 4 The DTE indicator is an abbreviation for Data Terminal Equipment indicator. The purpose of the DTE indicator is to inform distant receiving applications that, if set to "available," the transmitting station conforms, at least, to the minimum keyboard and display requirements. The DTE indicator is only used as information provided to the application layer - indicating that the transmitting station is available for communications. On the transmitting side, the DTE indicator may be set by an external application using this sentence. DTE indicator flag values are:

- 0 = Keyboard and display are a standard configuration, and communication is supported.
- 1 = Keyboard and display are either unknown or unable to support communication (default setting).

### G.2.8 VDM - VHF Data-link Message

This sentence formatter is used to transfer the entire contents of a received AIS message packet, as defined in ITU-R M.1371 and as received on the VHF Data Link (VDL), using the "six-bit" field type. The structure provides for the transfer of long binary messages by using multiple sentences.

`!AIVDM,x,x,x,x,s--s,x*hh<CR><LF>`



NOTE 1 The length of a binary message may require the transmission of multiple sentences. The first field specifies the total number of sentences used for a message, minimum value 1. The second field identifies the order of this sentence in the message, minimum value 1. These fields may not be null.

NOTE 2 Message "sequence identifier" is a message identification number from 0 to 9 that is sequentially assigned as needed. The sequence identifier is incremented for each new multi-sentence message. The count resets to 0 after 9 is used. For a message requiring multiple sentences, each sentence of the message contains the same message sequence identification number. It is used to identify the sentences containing portions of the same message. This allows for the possibility that other sentences might be interleaved with the message sentences that, taken collectively, contain a single message. This field shall be null for messages that fit into one sentence.

NOTE 3 When provided, the AIS channel is indicated as either "1" or "2." This channel indication is relative to the operating conditions of the transponder when the packet is received. This field shall be null when the channel identification is not provided.

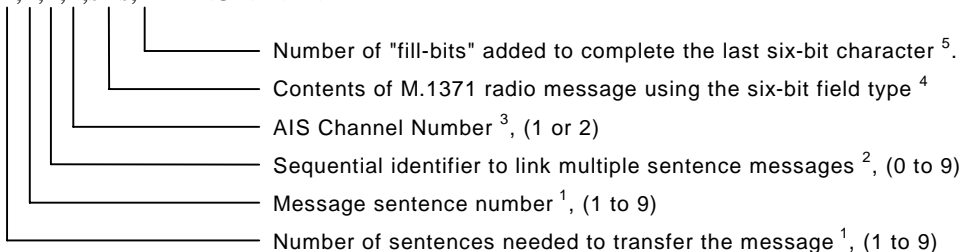
NOTE 4 The maximum string length of encapsulation is limited such that the total number of sentence characters does not exceed 82. This field supports a maximum of 62 valid characters for messages transferred using multiple sentences, and 63 valid characters for messages using a single sentence.

NOTE 5 Each character in the preceding six-bit coded character string represents six binary bits. This parameter indicates the number of bits that were added to the end of the binary packet as a result of creating the last character of the string. When the coding of the last six-bit character of the message packet does not create additional "fill-bits," this value shall be set to zero. The value "0" indicates that no "fill-bits" were added. This field may not be null.

### G.2.9 VDO - VHF Data-link Own-vessel message

This sentence formatter is used to transfer the entire contents of an AIS unit's broadcast message packet, as defined in ITU-R M.1371 and as sent out by the AIS unit over the VHF Data Link (VDL). It uses the six-bit field type for encapsulation. The sentence uses the same structure as the VDM sentence formatter. Refer to the VDM-sentence formatter for the "referenced notes."

`!AIVDO,x,x,x,x,s--s,x*hh<CR><LF>`

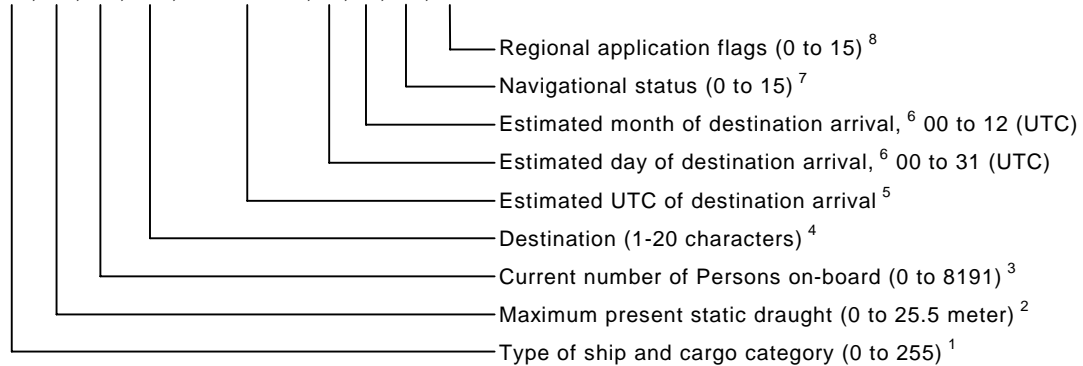


NOTES 1-5 See VDM-sentence notes.

### G.2.10 VSD - Voyage Static Data

This sentence is used to enter information about a ship's transit that remains relatively static during the voyage. However, the information often changes from voyage to voyage. The parameters in this sentence support a number of the ITU-R M.1371 messages. Portions of this information are use in ITU-R M.1371 messages; 1, 2, 3, 5, and 9.

\$--VSD,x.x,x.x,x.x,c--c,hhmmss.ss,xx,xx,x.x,x.x\*hh<CR><LF>



NOTE 1 Type of ship and cargo category are defined under Message 5 of ITU-R M.1371-1. Reference Tables 17.1 and 18. The description of ship and cargo are indicated by a number. Only values from 0 to 255 shall be accepted by the AIS unit. A null field indicates that this is unchanged. The values are defined as: 0 = not available or no ship (default); 1 to 99 = Defined in section 3.3.8.2.3.5, Table 18; 100 to 199 = preserved for regional use; 200 to 255 = preserved for future use.

NOTE 2 Draught in 0.1 meter increments from 0.1 to 25.4 meters. The value 0 = not available (default), and the value 25.5 indicates that the draught is 25.5 meters or more. Only values from 0 to 25.5 shall be accepted by the AIS unit. A null field indicates that this is unchanged.

NOTE 3 Current number of persons on-board, including crew. The value 0 = not available (default). The value 8191 = 8191 or more people. Only values from 0 to 8191 shall be accepted by the AIS unit. A null field indicates that this is unchanged.

NOTE 4 Current destination of vessel. A null field indicates that this is unchanged.

NOTE 5 The UTC time of arrival field follows the "TIME" field type described in Table 6 (IEC 61162-1). The two fixed digits of seconds are not broadcast by the AIS unit and can be set to "00". The optional decimal point and associated decimal fraction shall not be provided. The resulting time is a number with six fixed digits, "hhmm00". Leading zeros are always included for the hours and minutes. If the hour of arrival is not available, "hh" shall be set to 24. If the minute of arrival is not available, "mm" shall be set to 60. A null field indicates that this is unchanged.

NOTE 6 The day and month of arrival are in UTC. The day is a two fixed digit number with leading zeros always provided. The month is a two fixed digit number with the leading zeros always provided. If the day of arrival is not available, "00" shall be the number for day. If the month of arrival is not available, "00" shall be the number for the month. A null field indicates that this is unchanged.

NOTE 7 The Navigational status is indicated using the following values, a null field indicates the status is unchanged (ref. ITU-R M.1371, Message 1, Navigational status parameter):

0 = under way using engine (default)	4 = constrained by draught	8 = under way sailing
1 = at anchor	5 = moored	9 = reserved for High Speed Craft (HSC)
2 = not under command	6 = aground	10 = reserved for Wing In Ground (WIG)
3 = restricted maneuverability	7 = engaged in fishing	11 to 15 = reserved for future use

NOTE 8 Definition of values 1 to 15 provided by a competent regional authority. Value shall be set to zero (0), if not used for any regional application. Regional applications shall not use zero. A null field indicates that this is unchanged (ref. ITU-R M.1371, Message 1, Reserved for regional applications parameter).

### G.3 VDM - VHF Data-link Message Encapsulation Example

#### G.3.1 Introduction

The IEC 61162-1 standard supports the transport of encapsulated binary coded data. In general, the proper decoding and interpretation of encapsulated binary data will require access to information developed and maintained outside of the IEC 61162-1 standard. The IEC 61162-1 standard contains information that describes how the data should be coded, decoded, and structured. For AIS, the specific meaning of the binary data is obtained from the ITU-R M.1371 or this (IEC 61993-2) standard.

What follows is a practical example of how encapsulated binary coded data might be translated into meaningful information. The example is drawn from the operation of universal Automatic Identification System (AIS) equipment built to the ITU-R M.1371 recommendations. The sample sentence that will be used in this example is:

!AIVDM,1,1,,1,1P0000h1IT1svTP2r:43grwb0Eq4,0\*71<CR><LF>

Also included with this example are a worksheet, Figure G-2, and a copy of IEC 61162-1, Table 7.

#### G.3.2 Background Discussion - encapsulation coding

Before diving into the decoding process, it is useful to understand the source of the binary bits encapsulated in this string. AIS is radio technology that broadcasts messages using channels in the marine VHF band. There are a number of messages that can be broadcast by an AIS unit. The bit-by-bit descriptions of the contents of these messages are documented in tables contained in the ITU-R M.1371 international standard for AIS. Table 15 of this document is used in this example. Table 15 identifies all of the information needed to convert the encapsulated binary bits into information. The table identifies the bits, gives them parametric names, and units.

The bits listed in Table 15 are the Message Data portion of a larger packet of binary bits that are created and broadcast by an AIS unit. The sample VDM sentence shown above is an example of the output that would be created by every AIS unit that properly received a single AIS unit's broadcast. The following diagram, Figure G-1, shows the various portions of the

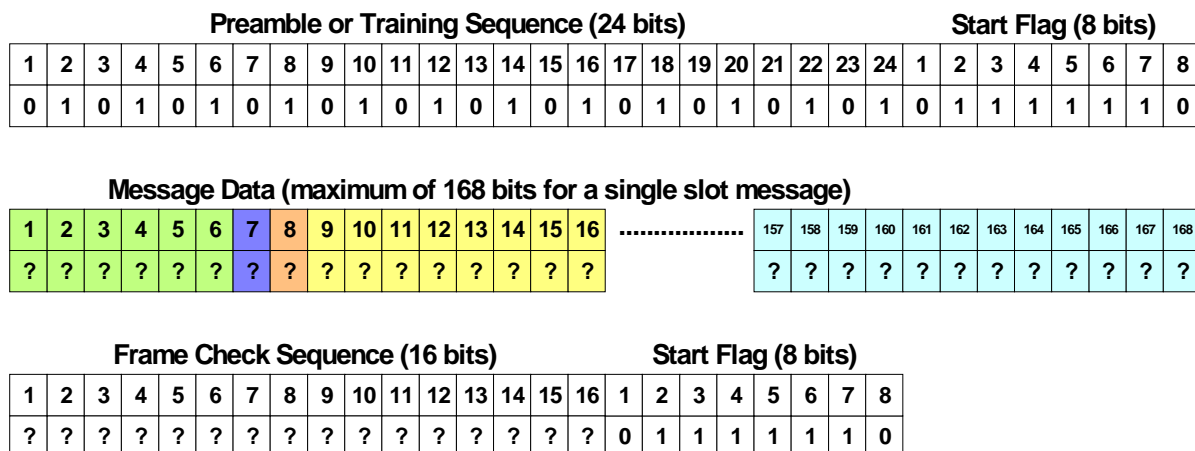


Figure G-1 - Radio Signal source of encapsulated VDM binary data.

"radio packet" that are created and broadcast by an AIS unit. The additional bits that are added to the information bits are needed to facilitate the use of radio signals to broadcast the packet. These additional bits are automatically removed by the receiving AIS units. Only the Message Data bits (those described in the tables - such as Table 15) are encapsulated in the string contained in the VDM sentence. Examples of some of the extra bits that are removed

before creating the encapsulation string, are labeled in Figure G-1 as Preamble, Start Flag, and Frame Check Sequence.

Assume, as an example, that the first 12 bits of the Message Data in Figure G-1 (bits 1 to 12) are: 000001100000. These would be the first 12 bits coded into the VDM encapsulated string. The VDM sentence encapsulates data using the symbols of the "6-bit" Field Type. Each of the 64 possible combinations of one's and zero's that can make up a 6-bit string has been assigned a unique valid character. These assignments are listed in Table 7 of IEC 61162-1, *Six-bit Binary Field Conversion Table*, (see Annex G.4.7).

For example, the first 12 bits would be divided into 6-bit strings, that is: 000001 and 100000. Using Table 7, the binary string 000001 can be represented by a "1", and the binary string 100000 can be represented by a "P". The first two characters in the VDM sentence encapsulated string would then be "1P". Note that observing upper and lower case letters is important when using Table 7.

The maximum number of Message Data bits, that can be contained in an AIS radio message, is 1008 bits. This number of bits requires 168 6-bit symbols. This quantity of characters is too many for a single sentence. Standard sentences cannot contain more than 82 characters, and that limit includes a number of required characters. When coding or decoding the encapsulation string, the string itself may require several sentences to transfer. The VDM sentence structure has been designed to allow an encapsulation string to be broken into smaller strings that are transferred using multiple sentences. The important point to remember is this. Treat the "broken strings" or "reconstructed string" as one continuous string. After all, the complete string contains the continuous "Message Data" portion of an AIS radio packet (see Figure G-1).

Although the string being used in this example can fit in one sentence, it could also be broken and transferred using two sentences. In fact, it need not be broken at any specific point. The two sentence pairs below are equivalent and are proper sentences for the transfer of the same encapsulation string.

```
!AIVDM,2,1,7,1,1P0000h1IT1svT,0*58<CR><LF>
!AIVDM,2,2,7,1,P2r:43grwb0Eq4,0*7C<CR><LF>

!AIVDM,2,1,9,1,1P0000h1IT1svTP2r:43,0*7B<CR><LF>
!AIVDM,2,2,9,1,grwb0Eq4,0*5F<CR><LF>
```

Note that the complete encapsulated Message Data string itself does not change in the two pairs, but that the "checksum" for the sentences does change. Using either VDM encapsulation pair, the encapsulated string remains: 1P0000h1IT1svTP2r:43grwb0Eq4.

Figure G-1 shows the Message Data as a horizontal table of bits. This can be shown in other ways. The left table in Figure G-2 shows how the Message Data bits can be redrawn in a table with 6 columns and as many rows as are needed to hold all the Message Data bits. The numbers in each of the table positions indicates the Message Data position of the bit in the AIS unit's broadcast. Organizing the bits in this manner allows easy use of the conversion information shown in Table 7.

The following discussion will use "table lookup" methods to describe the decoding process. The reader should also be aware that this standard also contains binary mathematical methods that a computer would use to accomplish the same results.

### G.3.3 Decoding the Encapsulated String

The **Background Discussion**, above, described how the AIS unit codes the received binary Message Data bits into the characters of an encapsulation string. It explained that the AIS unit:

- Receives a broadcast message,
- Extracts the Message Data from the radio signal,
- Organizes the binary bits of the Message Data into 6-bit strings,
- Converts the 6-bit strings into their representative "valid characters" - see Table 7,
- Assembles the valid characters into an encapsulation string, and
- Transfers the encapsulation string using the VDM sentence formatter.

Again, the sample sentence that will be used in this decoding and interpretation example is:

```
!AIVDM,1,1,,1,1P0000h1IT1svTP2r:43grwb0Eq4,0*71<CR><LF>
```

A calculation shows that the checksum, 71<sub>HEX</sub>, is correct. This permits the interpretation of the sentence contents to continue. Based upon the definition of a "VDM" sentence (see section G.3.8), this is a "single sentence encapsulation of an AIS VHF data link message." This message was produced by an AIS unit. The binary data, that has been encapsulated, was received on the AIS unit's "AIS1" channel. Also, no bits were added to the binary string when it was encapsulated. The remainder of this example will focus on the proper interpretation of encapsulation string: "1P0000h1IT1svTP2r:43grwb0Eq4".

The process of decoding and interpreting the contents of the encapsulated string is a three step process:

- 5) The string symbols are converted back into the binary strings that they represent.
- 6) The binary strings are organised or parsed using the rules contained in the referenced document, in this case ITU-R M.1371-1, Table 15 (also Table 15 in this document).
- 7) The referenced document rules are used to convert the binary strings into the relevant information.

### G.3.4 Conversion from symbols to binary bits

Figure G-2 is a visual aid that can be used to follow this process for the example string. The table on the left side of Figure G-2, **VDM bit positions**, is provided as a reference that can be used to identify the exact bit position of the corresponding binary bit in the table on the right side, **Bits represented by encapsulation symbol**, of Figure G-2. The use of this "reference grid" will become more clear as the example is discussed.

Down the center of Figure G-2 is a column into which the example string has been entered from top to bottom. The arrows in Figure G-2 provide an idea about how the logic of the decoding process proceeds. Decoding of the VDM encapsulated string begins with the first symbol in the string. In this case the symbol is "1" and the corresponding binary string from Table 7 is "000001". The binary string is entered in the grid to the right of the "1", as indicated by the arrow. These six bits occupy bit positions 1 to 6. The left most "0" is in position 1 and the right most "1" is in position 6. Note how this corresponds with the reference diagram on the left of Figure G-2.

The second symbol in the string, "P", is processed next. The "P" represents the binary string "100000". This binary string is entered into the next row of the right grid - VDM bit positions 7 to 12. The same process is followed for each of the symbols of the encapsulate string down to the last one, which is a "4". The "4" represents the binary string "000100". This binary string is entered into the "last" row of the right grid - VDM bit positions 163 to 168.

The process of loading up the right grid with binary strings is a mechanical process that has nothing to do with the information content of the encapsulated binary data. It is simply the reverse process from what the AIS unit did to create the encapsulation string during the process of creating the VDM sentence.

### G.3.5 Organizing the Binary Message Data

The work sheet has been filled in to decode an "AIS Message 1". Notice that the two grids in Figure G-2 have a variety of shaded (colored) blocks. This was done to make it easier to

locate the specific bits making up the message 1 parameters in the decoded array of binary bits. The fact is, these blocks could not be filled in until the message type (message number) of AIS message was identified. Identification of the AIS message is done from the first six bits of the binary Message Data. The message number is simply the decimal equivalent of the binary number. In this case, 000001 = message 1. After this is known the remaining blocks of the message can be shaded using information in Table 15.

The parameters listed in Table 15 are transmitted over the radio link as Message Data in the same order that they are listed in the table. The "Number of bits" column of Table 15 used to establish the bits that apply to each of the parameters in the table (refer to Table 15):

- 1) Message ID, bits 1-6
- 2) DTE, bit 7
- 3) Data indicator, bit 8
- 4) User ID, bits 9-38
- 5) Navigation status, bits 39-42
- 6) Rate of turn, bits 43-50
- 7) SOG, bits 51-60
- 8) Position accuracy, bit 61
- 9) Longitude, bits 62-89
- 10) Latitude, bits 90-116
- 11) COG, bits 117-128
- 12) True Heading, bits 129-137
- 13) Repeat Indicator, bits 144-145
- 14) Reserved for regional applications, bits 146-149
- 15) Spare, bit 150
- 16) Communications State, bits 151-168

Once established, this ordering of bits will always be the same for a "message 1". That is, until the reference table itself is changed by a revision action of the ITU.

This same ordering should be done for each of the referenced AIS message tables. For example, if bits 1 through 6 were 010011 after the decoding process was complete, the VDM message identified would be message 19 ( $010011_2 = 19_{10}$ ). This reference is the "VTS Targets" message - Tables 31 and 32 of ITU-R M.1371. In the case of message 19, two tables would be referenced for the ordering and identification of the binary Message Data. The process of organizing the decoded binary Message Data requires:

- 1) Identification of the message number, and
- 2) Organizing or parsing the binary bits following the appropriate message table.

### G.3.6 Interpreting the Decoded Binary Strings

Final conversion of the organized bits into useful information involves the use of the:

- 1) Organized bits - right side of Figure G-2, and
- 2) The parameters descriptive information in Table 15.

For example, the parameter "DTE" is a single bit - bit 7. Inspection of Message Data bit 7, Figure G-2, shows that its value is "1". The descriptive information in Table 15 for "DTE" indicates that a "1" should be interpreted as "not available". This conclusion is recorded in the space to the right of Figure G-2.

Similar inspection of the "Data indicator", bit 8, shows that the indicated value of "0" should be interpreted as "not available". This conclusion is recorded in the space to the right of Figure G-2.

The next parameter in Table 15 is the "User ID" (the MMSI number of the unit that broadcast this message). This is a 30 bit binary integer. The conversion,  $1111111_2 = 127_{10}$ , discloses this units MMSI as 127.

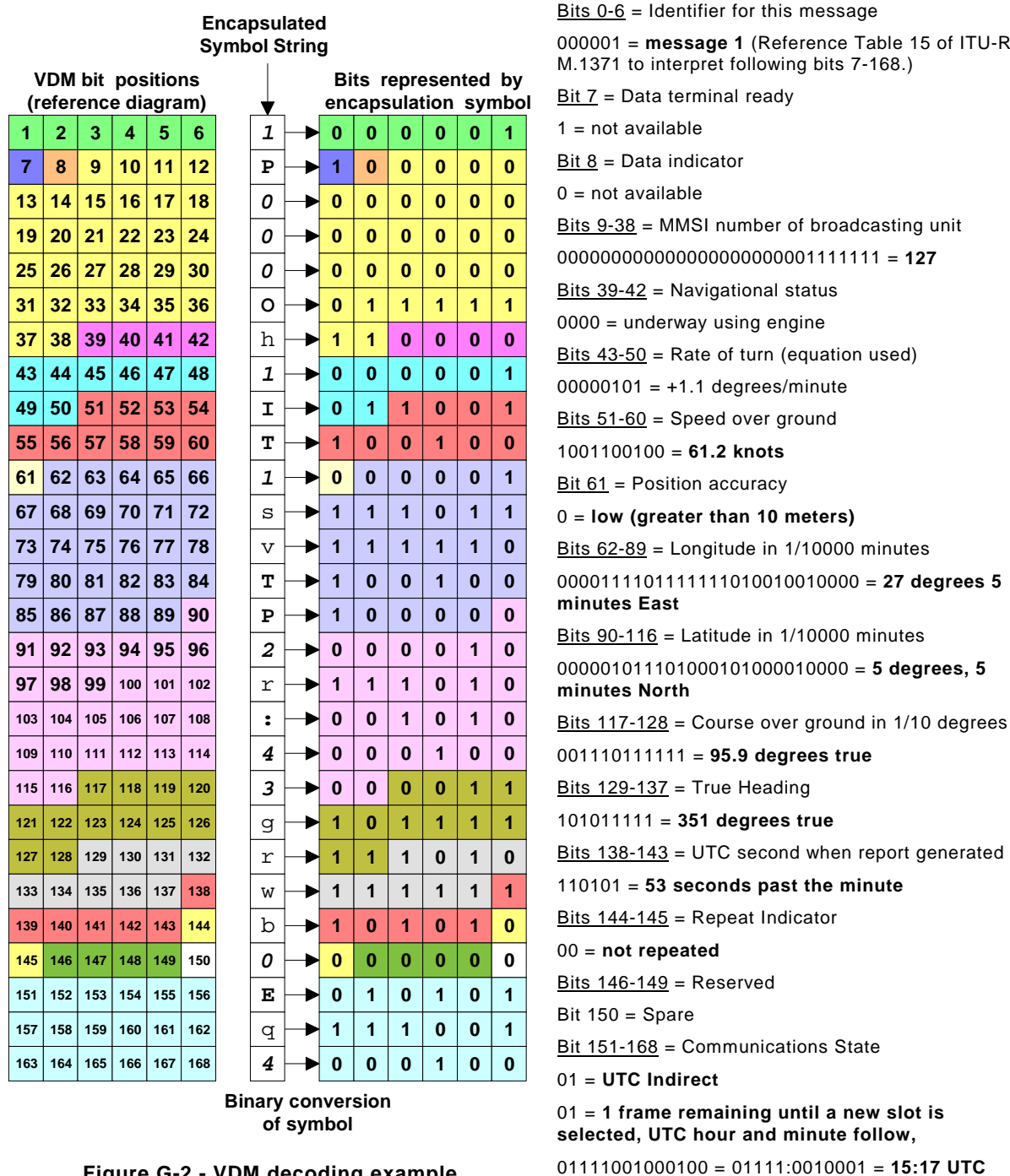
This process continues down Table 15. The results of each interpretation of the decoded binary Message Data are shown on the worksheet to the right of Figure G-2.

**Table G.1**

Six-Bit Binary Field Conversion Table proposed IEC 61162-1, Table 7			
Valid Character	<u>Binary Field</u>	Valid Character	<u>Binary Field</u>
0	000000	P	100000
1	000001	Q	100001
2	000010	R	100010
3	000011	S	100011
4	000100	T	100100
5	000101	U	100101
6	000110	V	100110
7	000111	W	100111
8	001000	'	101000
9	001001	a	101001
:	001010	b	101010
;	001011	c	101011
<	001100	d	101100
=	001101	e	101101
>	001110	f	101110
?	001111	g	101111
@	010000	h	110000
A	010001	i	110001
B	010010	j	110010
C	010011	k	110011
D	010100	l	110100
E	010101	m	110101
F	010110	n	110110
G	010111	o	110111
H	011000	p	111000
I	011001	q	111001
J	011010	r	111010
K	011011	s	111011
L	011100	t	111100
M	011101	u	111101
N	011110	v	111110
O	011111	w	111111

### G.3.7 Work sheet for decoding and interpreting encapsulated string:

1P0000h1IT1svTP2r:43grwb0Eq4



## **G.4 Computer methods to code and decode encapsulated VDL message data.**

### **G.4.1 Introduction**

The previous section used the "table-lookup" method to describe the coding and decoding of AIS VHF data-link message data encapsulated in IEC 61162-1 sentences. Table-lookup is an efficient computer method. However, the symbols shown in IEC 61162-1, Table 7 were selected such that mathematical computer methods could also be used to code and decode the encapsulated message data. This section provides the technical background needed to implement mathematical computer methods.

### **G.4.2 Review of IEC 61162-1 "ASCII characters"**

All information transmitted across the 61162-1 (and 61162-2 "high speed") interface is coded as ASCII characters. ASCII characters are commonly understood to be eight bits in length. The IEC 61162-1 designates that the most significant bit of these eight-bit characters shall always be transmitted as zero. The remaining seven bits allow for 128 possible combinations of symbols. Of these, a portion are used to represent printable characters and the remaining represent machine or control "actions."

The symbols that were chosen to represent the sixty-four possible 6-bit binary combinations in IEC 61162-1, Table 7 were taken from the sub-set of printable characters that IEC 61162-1 designates as "valid characters" (see IEC 61162-1, Table 2). Of the "valid character" sub-set, selected characters have been designated by IEC as reserved. As such, they have special "control" meanings within the IEC 61162-1 standard. These reserved characters cannot be used to represent data. The valid characters that were chosen to represent the sixty-four possible 6-bit binary combinations are shown below in Table G-1 along with the ASCII-code for each valid character.

### **G.4.3 Correspondence between ASCII-coded characters and 6-bit binary fields**

The valid characters chosen to represent the sixty-four 6-bit binary combinations are themselves represented by 8-bit binary combinations. These are the combinations that the computer uses to represent the characters that it transmits to the outside world. Table G-1 contains the specific association between the 8-bit "ASCII-coded" characters defined in IEC 61162-1 and the 6-bit binary combinations used to encapsulate AIS message data. This is the fundamental "mathematical" information that is needed to create a computer algorithm that either converts 8-bit ASCII representations to 6-bit binary combinations, or 6-bit binary combinations to 8-bit ASCII representations. The assignment of the valid characters, to represent the 6-bit binary combination, was done in such a way that mathematical algorithms could be created.

For example, the character "E" represents the 6-bit binary field "010101" as shown above in the IEC 61162-1, Table 7. However, the character "E" is represented by the binary ASCII string "01000101" by the computer. There is a mathematical functional relationship between the two binary numbers. The following mathematical computer algorithms can be used to design software that directly converts ASCII binary strings to the 6-bit binary field they represent, or 6-bit binary fields to the ASCII binary strings that represent them.

### **G.4.4 Method to convert 6-bit binary to ASCII-code**

A mathematical function that will convert a 6-bit binary field to the ASCII-code for the valid character used to represent that binary field, is shown in the logic diagram, Figure G-3. This logic diagram represents the processing required to convert the 6-bit binary field into the appropriate ASCII-code. As a example, take the 6-bit binary number 010101. This value is first tested to determine if it is less than the binary number 101000. In this case, it is. The process continues following the "YES" track in Figure G-3. The ASCII-code for 010101 becomes the sum of  $010101 + 00110000 = 01000101$ . A check of Table G-1 will confirm that this is the ASCII-code for {E}.

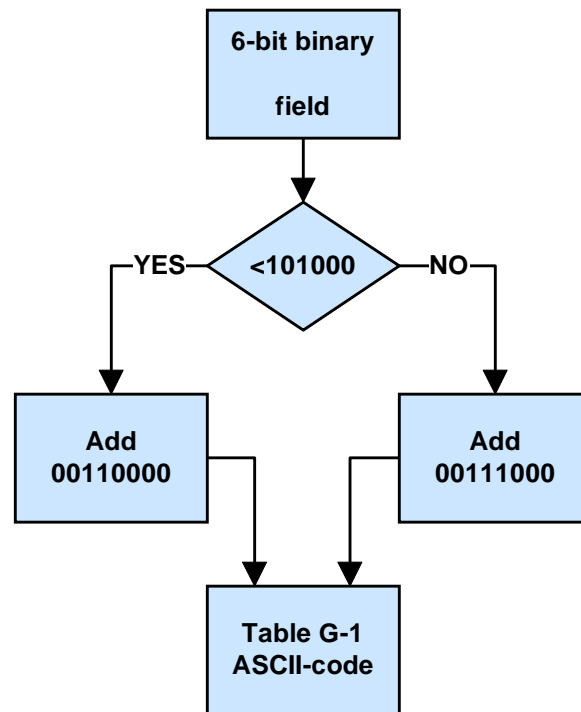
Table G-1

## 6-Bit binary Fields represented by Valid IEC 61162-1 ASCII Character Codes

ASCII HEX = binary	Valid Character	Binary Field represented	ASCII HEX = binary	Valid Character	Binary Field represented
30 = 00110000	0	000000	50 = 01010000	P	100000
31 = 00110001	1	000001	51 = 01010001	Q	100001
32 = 00110010	2	000010	52 = 01010010	R	100010
33 = 00110011	3	000011	53 = 01010011	S	100011
34 = 00110100	4	000100	54 = 01010100	T	100100
35 = 00110101	5	000101	55 = 01010101	U	100101
36 = 00110110	6	000110	56 = 01010110	V	100110
37 = 00110111	7	000111	57 = 01010111	W	100111
38 = 00111000	8	001000	60 = 01100000	'	101000
39 = 00111001	9	001001	61 = 01100001	a	101001
3A = 00111010	:	001010	62 = 01100010	b	101010
3B = 00111011	;	001011	63 = 01100011	c	101011
3C = 00111100	<	001100	64 = 01100100	d	101100
3D = 00111101	=	001101	65 = 01100101	e	101101
3E = 00111110	>	001110	66 = 01100110	f	101110
3F = 00111111	?	001111	67 = 01100111	g	101111
40 = 01000000	@	010000	68 = 01101000	h	110000
41 = 01000001	A	010001	69 = 01101001	i	110001
42 = 01000010	B	010010	6A = 01101010	j	110010
43 = 01000011	C	010011	6B = 01101011	k	110011
44 = 01000100	D	010100	6C = 01101100	l	110100
45 = 01000101	E	010101	6D = 01101101	m	110101
46 = 01000110	F	010110	6E = 01101110	n	110110
47 = 01000111	G	010111	6F = 01101111	o	110111
48 = 01001000	H	011000	70 = 01110000	p	111000
49 = 01001001	I	011001	71 = 01110001	q	111001
4A = 01001010	J	011010	72 = 01110010	r	111010
4B = 01001011	K	011011	73 = 01110011	s	111011
4C = 01001100	L	011100	74 = 01110100	t	111100
4D = 01001101	M	011101	75 = 01110101	u	111101
4E = 01001110	N	011110	76 = 01110110	v	111110
4F = 01001111	O	011111	77 = 01110111	w	111111

A similar calculation can be done using a 6-bit binary field that is greater than 101000. For example, calculate the ASCII-code for 111101. This value is greater than the binary number 101000, so, the process follows the "NO" track in Figure G-3. The ASCII-code for 111101 becomes the sum of 111101 + 00111000 = 01110101. A check of Table G-1 will confirm that this is the ASCII-code for {u}.

Finally, a calculation can be done for the test value. That is, what is the ASCII-code for the 6-bit binary field 101000? This value is not less than the binary number 101000, so, the process follows the "NO" track in Figure G-3. The ASCII-code for 101000 becomes the sum of 101000 + 00111000 = 01100000. A check of Table G-1 will confirm that this is the ASCII-code for {'}.



**Figure G-3 - Computer process to convert 6-bit binary field to ASCII-code of the symbol representing the 6-bit binary field.**

#### **G.4.5 Method to convert ASCII-coded character to 6-bit binary**

The mathematical process for converting an ASCII-code into the 6-bit binary field is more complex than the 6-bit binary to ASCII-code process described above. The complexity is caused by the fact that the ASCII-code must be tested to ensure that it represents a valid symbol. If the ASCII-code is not valid, the mathematical process should exit through a process that properly terminates the decoding of an encapsulated message. The detection of a single incorrect character in the encapsulation string should end with rejection of the string.

Figure G-4 is the logic diagram representing the ASCII-code to 6-bit binary field conversion process. The initial three tests will detect an error if the ASCII-code (also abbreviated **Code**) is not one of the codes listed in Table G-1. If the ASCII-code does appear in Table G-1, the answer to the first three tests will all be NO, and the value 101000 will be added to the ASCII-code. If the resulting sum of this addition is less than or equal to 10000000, the value 101000 is added to the number. If the resulting sum from the addition is greater than 10000000, the value 100000 is added to the number. After either operation, the six least significant bits (LSB, six right most bits) of the sum are equal to the appropriate binary number.

As an example, consider the ASCII-code 00110000. This code is in Table G-1 and passes the first three decisions. The value 101000 is added to it, and the sum is 01011000. Since this value is less than 10000000, the value 101000 is added to it, and the resulting sum is 10000000. The six LSB are 000000. A check of Table G-1 confirms that this is the correct binary field for the {0} (zero) character.

As a second example, consider the ASCII-code 01110101. This code also passes the first three decisions. The value 101000 is added to it, and the sum is 10011101. Since this value is greater than 10000000, the value 100000 is added to it, and the resulting sum is 10111101. The six LSB are 111101. A check of Table G-1 confirms that this is the correct binary field for the {u} character.

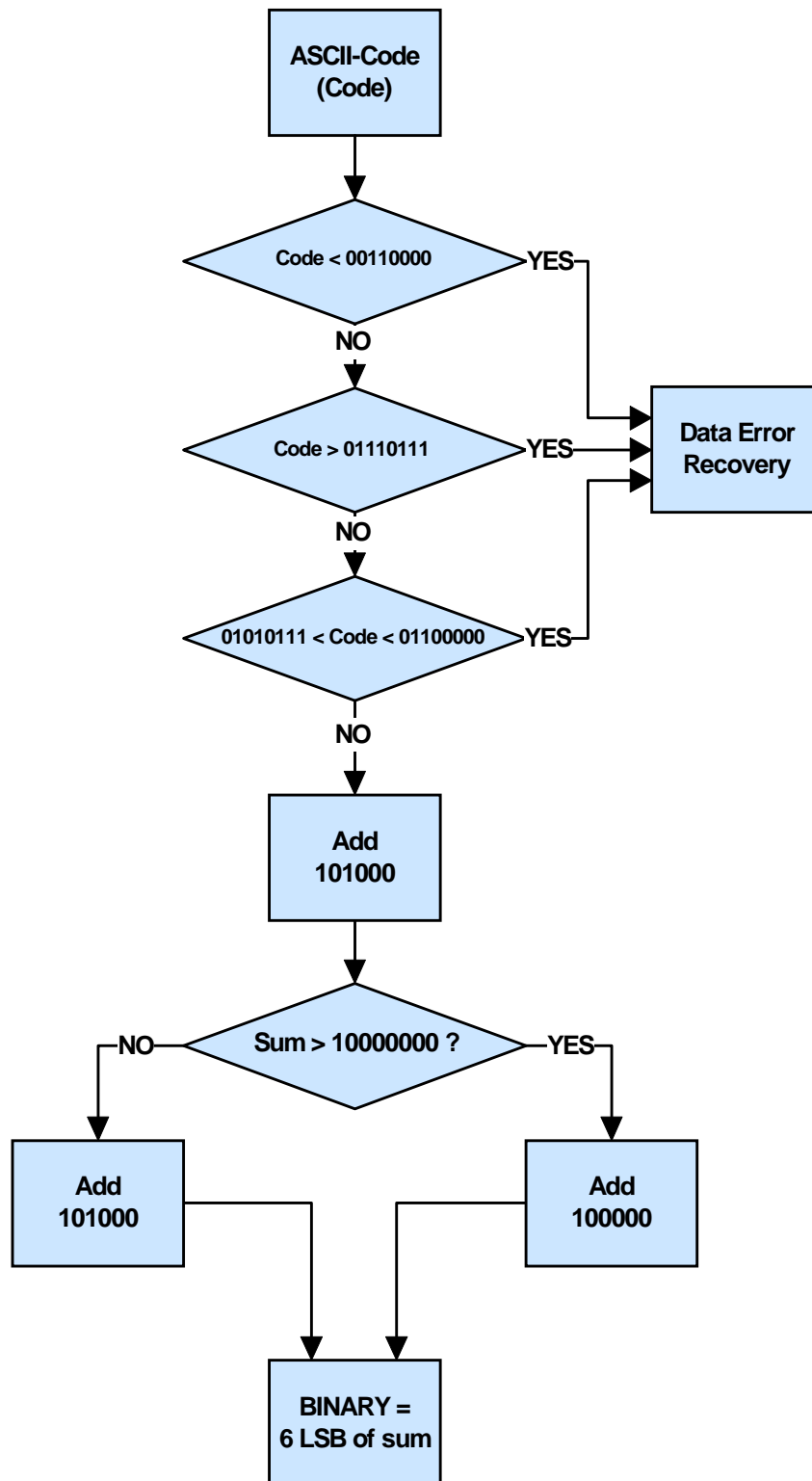


Figure G-4 - Computer process to convert ASCII-code to 6-bit binary field.

## **Annex H Informative Long range application**

### **H.1 Introduction**

The responsibility of administrations for wide area or offshore monitoring of shipping traffic include safety of navigation, search and rescue (SAR), resource exploration and exploitation and environmental protection in offshore areas including the continental shelf and economic exclusion zones (EEZ). In certain areas the monitoring of tank vessel movements in accordance with any established Tanker Exclusion Zone (TEZ) must be applied. Examples are:

- There is currently a TEZ on the West Coast of Canada.
- There is a mandatory route for larger tankers from North Hinder to the German Bight and vice versa as described in IMO document MSC 67/22/Add 1-Annex 11.
- There are two reporting systems in Australia: AUSREP and REEFREP, both adopted by IMO, which will use the LR application.
- For the long-range (LR) AIS application is chosen for the general principles for ship reporting as described in IMO resolution A.851(20). AUSREP as well as the Canadian application already adopt this method.

The LR application of AIS must operate in parallel with the VDL. LR operation will not be continuously. The system will not be designed for constructing and maintaining of real time traffic images on a large area. Position updates will be in the order of 2-4 times per hour (maximum). Some applications require an update of just two times a day. It can be stated that LR application forms hardly any workload to the communication system or the transponder and will not interfere with the normal VDL operation.

The LR operational mode will be on interrogation base only for geographical defined areas. Shore base stations shall interrogate AIS systems, initially by geographical area, followed by addressed interrogation. Only standard available AIS information will be replied e.g. position and static and voyage-related data.

The communication system for LR-AIS is not defined in this document. Inmarsat-C, as part of GMDSS on many vessels, can be a candidate to facilitate the LR application, but this will not be mandatory. Most of the current Inmarsat-C, but also all other long-range communication systems, does not support the IEC 61162-2 interface. Because the IEC 61162 series will be standard on all future maritime onboard systems, AIS will be supported by this interface only. This requires for long range application an active interface box to translate the LR AIS 61162-2 messages to the required messages suitable for the chosen communication system and vice versa. This active interface can also gather the information which is not standard available in the AIS. This can be another information system aboard (if installed).

The responsibility of administrations for wide area or offshore monitoring of shipping traffic include safety of navigation, search and rescue (SAR), resource exploration and exploitation and environmental protection in offshore areas including the continental shelf and economic exclusion zones (EEZ). In certain areas the monitoring of tank vessel movements in accordance with any established Tanker Exclusion Zone (TEZ) must be applied. Examples are:

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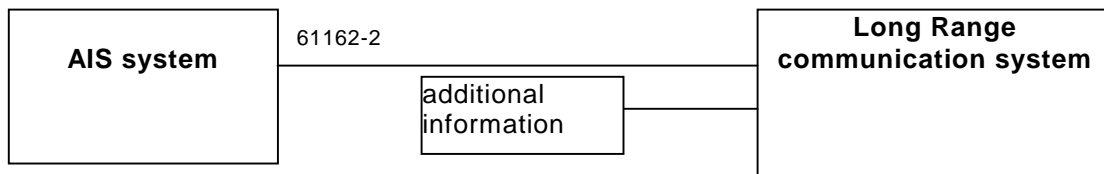
The LR application of AIS must operate in parallel with the VDL. LR operation will not be continuously. The system will not be designed for constructing and maintaining of real time traffic images on a large area. Position updates will be in the order of 2-4 times per hour (maximum). Some applications require an update of just two times a day. It can be stated that LR application forms hardly any workload to the communication system or the transponder and will not interfere with the normal VDL operation.

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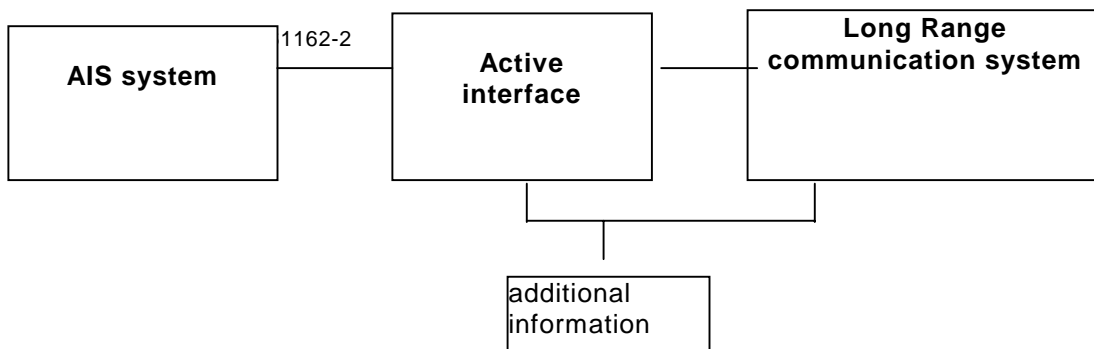
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## H.2 Configuration

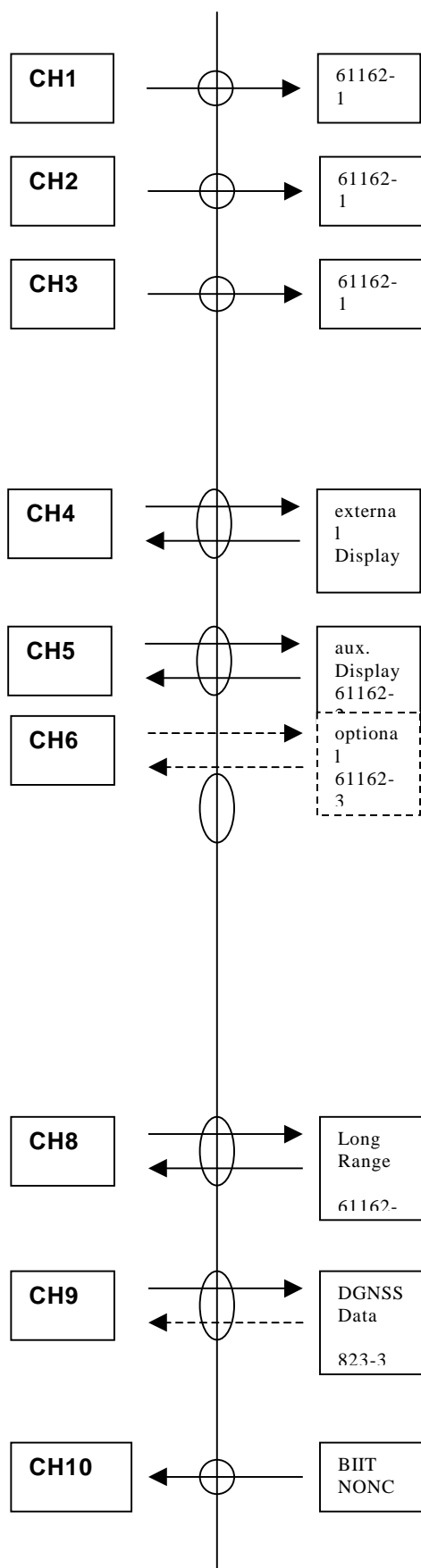
The general set-up of the LR configuration is given below.



No IEC 61162-2 interfaces exist for LR communication systems, the following configuration can be used as an interim solution.



## Annex I Normative AIS Interface Overview



### Sensor Inputs

#### Minimum required input sentences:

Position	GNS, DTM	
int/ext *		
SOG	VBW	ext
COG	RMC	ext
Heading	HDT	ext
Rotation Rate	ROT	ext
[Route	RTE, WPL	<i>optional</i> ]
[Attitude	ATT	<i>optional</i> ]

\* if external data available, this has priority

### Input / Output of AIS Data

#### INPUT

manual Data Input:  
 VoyageVSD  
 Static SSD  
VDL-messages:  
 ABM  
 BBM  
 ASM  
 ABM  
 AIR Interrogation  
Other:  
 ACK Alarm ack.

#### OUTPUT

VDL-messages:  
 VDM  
 (Data block of VDM representing binary Data contents of VDL messages)  
Other:  
 VDO Own ship data  
 ALR Alarm status  
 ABK VDL ack.

### Long Range Port

Input LRI, LRF

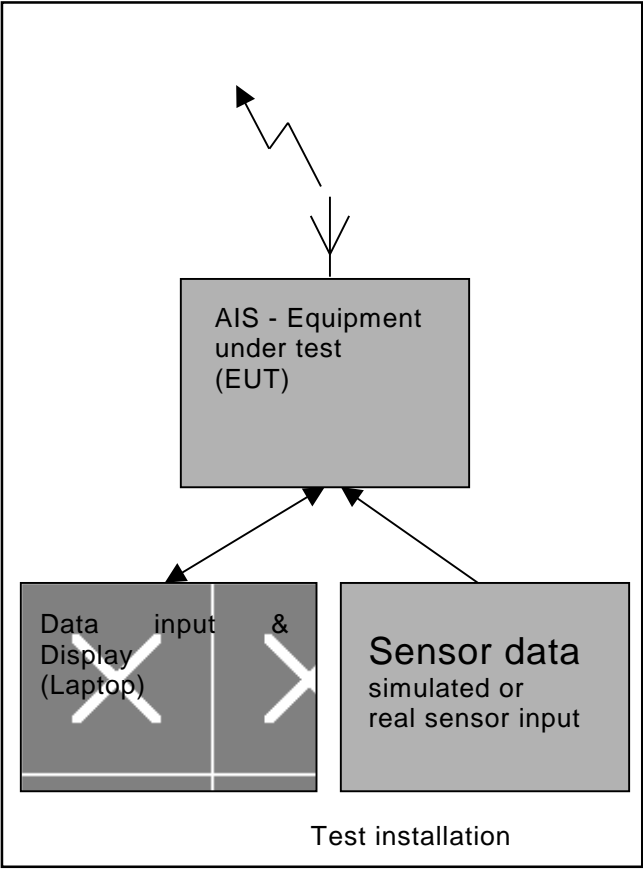
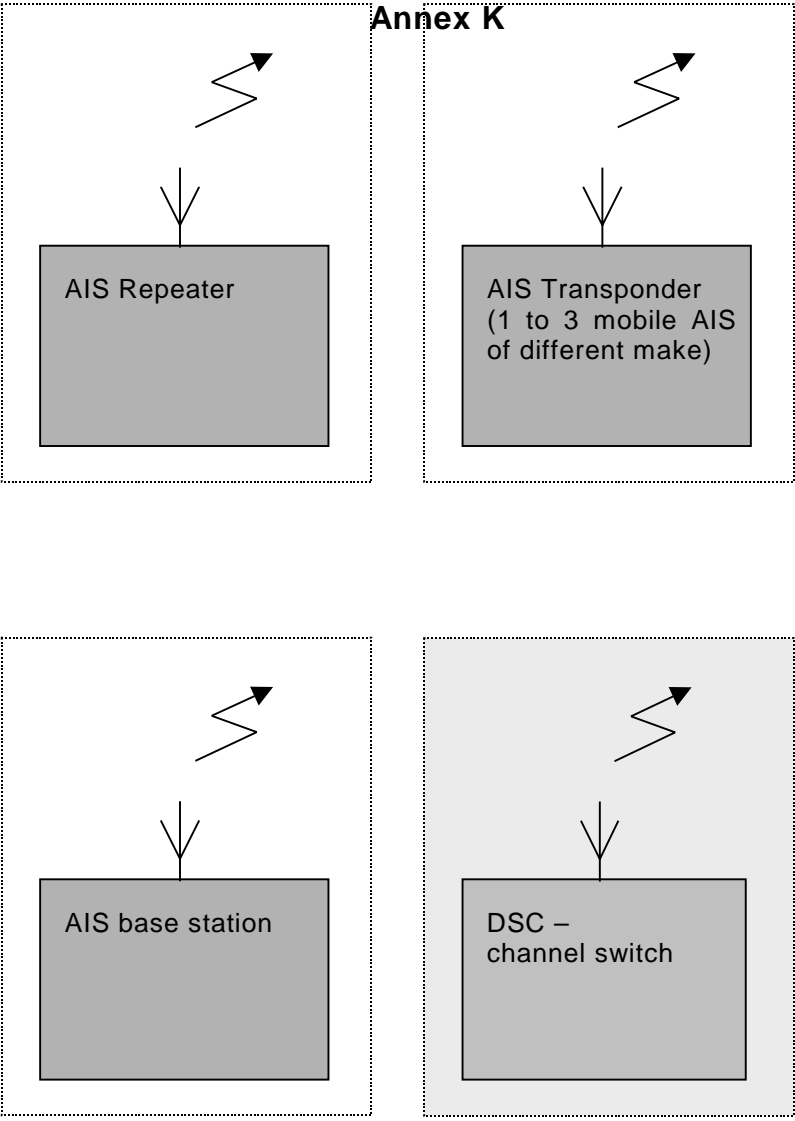
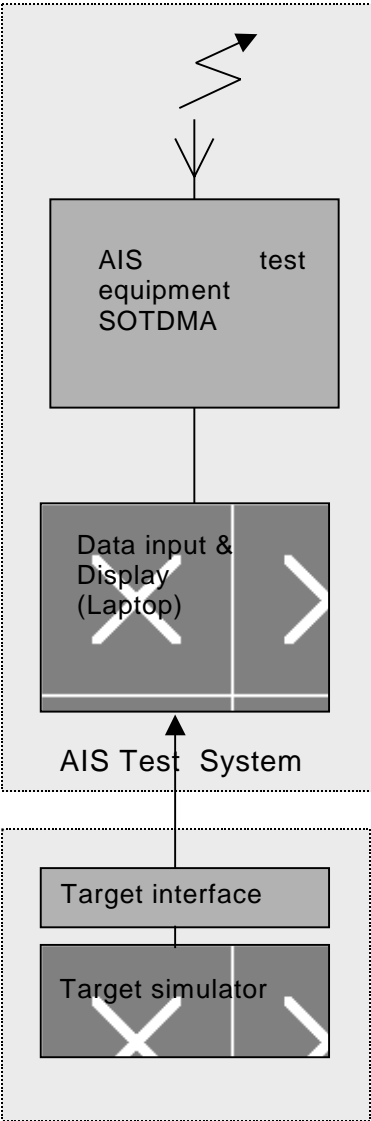
Output LR1,2,3

### DGNSS-Data Port

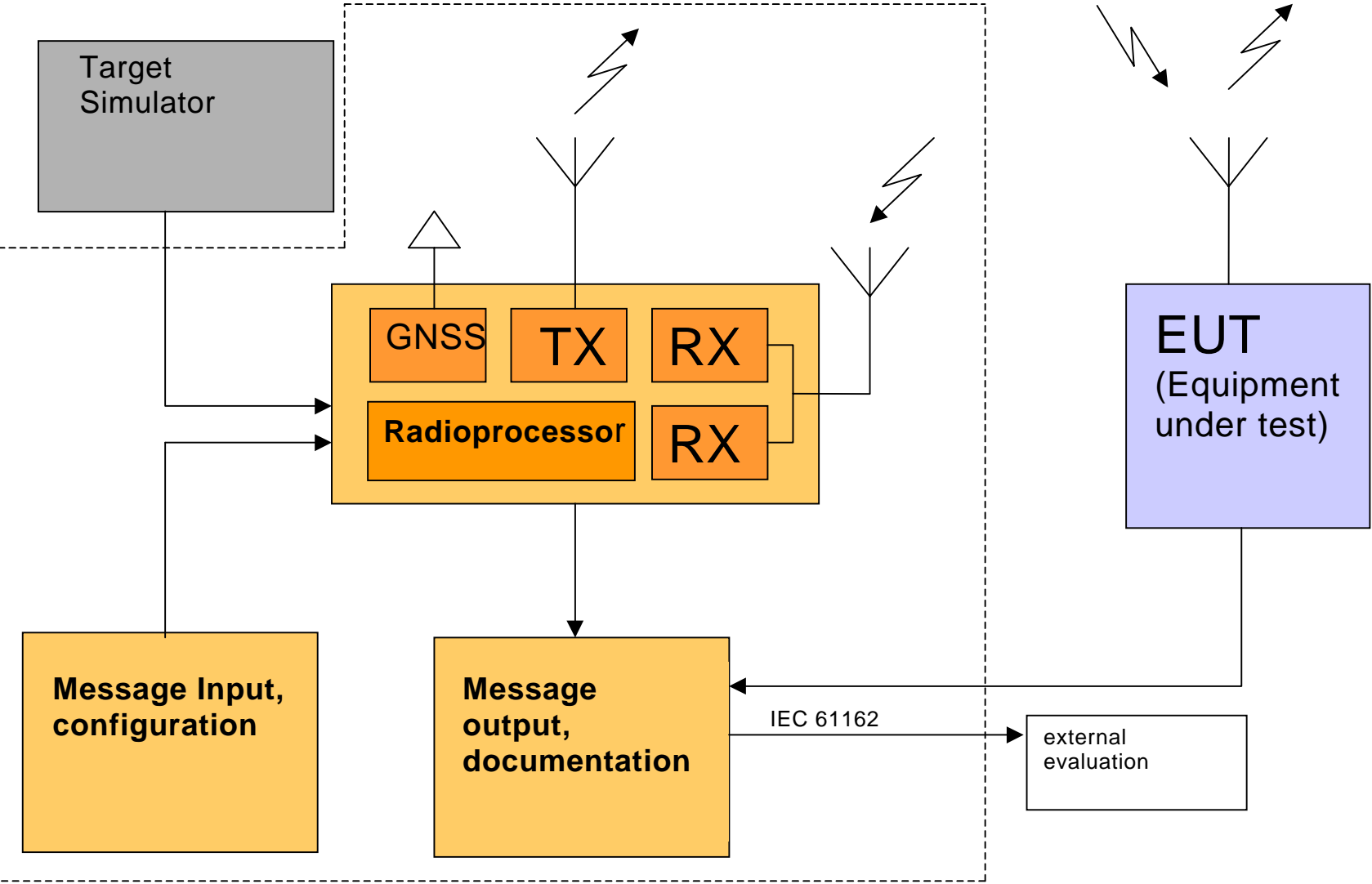
Correction data Information

### BIIT Output Port

Annex J Normative AIS test environment overview



Annex K Normative Block diagram of AIS test system



## **Annex L Informative Description of operation of the DSC part**

### **L.1 General**

1. *[The shore station shall ensure that the total DSC traffic shall be limited to 0.075 Erlang in accordance with Recommendation ITU-R M.822.]*

2. *Shore stations that transmit DSC all-ships calls to designate AIS regions and frequency channels shall schedule their transmissions such that ships transiting these regions will receive sufficient notice to be able to perform the operations in paragraphs 6.4.1.1 to 6.4.1.5. A transmission interval of 15 minutes is recommended, and each transmission shall be made twice, with a time separation of 500 milliseconds between the two transmissions, in order to insure that reception by AIS transponders is accomplished.*

### **L.2 (M.1371/A3-2.3) Regional channel designation**

1. *For designation of regional AIS frequency channels, Expansion Symbols No. 09, 10 and 11 shall be used in accordance with Table 5 of Recommendation ITU-R M.825-3. Each of these Expansion Symbols shall be followed by two DSC symbols (4 digits) which specify the AIS regional channel(s), as defined by Recommendation ITU-R M.1084-2, Annex 3. This allows for simplex, duplex, 25 kHz and 12.5 kHz channels for regional options, subject to the provisions of Appendix S18 of the Radio Regulations. Expansion Symbol No. 09 shall designate the primary regional channel, and Expansion Symbol No. 10 or 11 shall be used to designate the secondary regional channel.*

2. *For designation of regional AIS frequency channels, Expansion Symbols No. 09, 10 and 11 shall be used in accordance with Table 5 of Recommendation ITU-R M.825-3. Each of these Expansion Symbols shall be followed by two DSC symbols (4 digits) which specify the AIS regional channel(s), as defined by Recommendation ITU-R M.1084-2, Annex 3. This allows for simplex, duplex, 25 kHz and 12.5 kHz channels for regional options, subject to the provisions of Appendix S18 of the Radio Regulations. Expansion Symbol No. 09 shall designate the primary regional channel, and Expansion Symbol No. 10 or 11 shall be used to designate the secondary regional channel.*

3 *When single-channel operation is required, then only Expansion Symbol No. 09 shall be used. For two-channel operation, either Expansion Symbol No. 10 shall be used to indicate that the secondary channel is to operate in both transmit and receive modes, or Expansion Symbol No. 11 shall be used to indicate that the secondary channel is to operate only in receive mode.*

### **L.3 (M.1371/A3-2.4) Regional area designation**

For designation of regional areas for utilising AIS frequency channels, Expansion Symbols Nos. 12 and 13 shall be in accordance with Table 5 of Recommendation ITU-R M.825-3. Expansion Symbol No. 12 shall be followed by the geographical co-ordinate address of the north-eastern corner of the Mercator projection rectangle to the nearest tenth of a minute. Expansion Symbol No. 13 shall be followed by the geographical co-ordinate address of the south-western corner of the Mercator projection rectangle to the nearest tenth of a minute.